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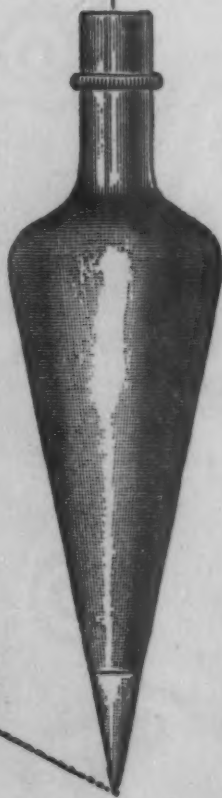
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1967

EDITORIAL



Because man's days are numbered, it is in the nature of human institutions that there be a succession of individuals who serve them. The ANNALS OF SURGERY was founded in 1884 by Lewis Stephen Pilcher. At that time it was the only journal published in the English language which was devoted exclusively to surgery. For fifty years Pilcher was the Editor of the ANNALS. He alone guided its policies and was responsible for its high standards and integrity. Surgery owes much to the genius of this dean of surgical journalism.

In 1935 Dr. Pilcher resigned as Editor-in-Chief, and the editorial supervision of the journal fell upon the shoulders of an Editorial Board. This Editorial Board was broadly representative of surgical teaching and practice in the United States and Canada. For the ensuing twelve years this Board was responsible for the selection and revision of manuscripts submitted for publication. The members of the Board have guided the policies of the ANNALS, and under their leadership the ANNALS has maintained and strengthened its position.

Beginning with this first issue of Volume 126 there occurs again a broadening of the editorial supervision. Eight former members of the Editorial Board move to a senior position on an Advisory Board, where they will continue to take an active interest in the

policies of the ANNALS, assist in the editorial supervision, and aid the Editorial Board with their advice and judgment.

To fill the vacancies thus created on the Editorial Board, the following surgeons have been elected:

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NATHAN A. WOMACK, *Associate Professor of Clinical Surgery, Washington University School of Medicine, St. Louis, Missouri*

It is a great pleasure, on behalf of the Publishers and the Editorial Board to welcome these new members of the Board. I am confident that we, who constitute the younger members of the Editorial Board, will be able, with the assistance and advice of the senior members of the Editorial and Advisory Boards, to carry on the fine traditions of the ANNALS OF SURGERY.

—JOHN H. GIBBON, JR.

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No. 1



GASTRIC NEURECTOMY FOR GASTRIC AND DUODENAL ULCERATION*

AN ANATOMIC AND CLINICAL STUDY

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DRAGSTEDT'S¹ interesting studies on the effect of resection of the vagus nerves in more than 100 cases of peptic ulcer and similar promising studies by Grimson, Moore and their associates^{2, 3} have led us to attempt to study the problem from the anatomic, clinical and experimental standpoint. We began our work by an anatomic study of the distribution of the vagus nerves above and below the diaphragm in order to determine their relative position, number and size and whether the thoracic or abdominal approach to them along the lower part of the esophagus and the upper part of the stomach was best. In dissection in more than 100 cases at necropsy (56 men, 44 women and 11 children) we found, as Miller⁴ previously found, a marked variation in the anatomic distribution of the vagus nerves, which in the present study of their relation to the lower part of the stomach and esophagus we shall term "gastric nerves."

Because of the bizarre results following resection of the vagus nerves in experimental animals, we have reviewed the literature on the subject and also the reports of the results of the operation in the treatment of peptic ulcer of human beings to November 1, 1946. Resections of the vagus or

* Read before the 58th Annual Session of the Southern Surgical Association, Hot Springs, Va., December 12, 1946.

gastric nerves have been done at the Mayo Clinic in the treatment of peptic ulcer in 66 cases. In this paper we are reporting on the immediate results of the operation performed by one of us (W. W.) on 33 patients (Tables I, II and III), and are commenting on the indication for the operation. Brief mention also will be made of 33 cases in which other surgeons at the clinic performed the operations. Some of these are listed in Table IV.

Denervation of the stomach is not a new concept in the treatment of peptic ulcer, and an extensive and confusing literature has appeared since Brodie's⁵

TABLE I
GASTRIC NEURECTOMY (VAGOTOMY): AUTHORS' CASES

| Case | Lesion | Total and Free Acids and Gastric Contents | | Minimal Blood Sugar, Mg. per 100 cc. | Curve of Insulin Test | Roentgenologic Findings | Comment and Results |
|------|-------------------------|---|-----------------------------|--------------------------------------|-----------------------|---|---|
| | | Before Operation | After Operation | | | | |
| 1 | Gastro-jejunal ulcer | 28/12 45 cc. | 40/0 40 cc. | 20 | Flat | | Good relief |
| 2 | Gastro-jejunal ulcer | 32/16 60 cc. | 12/0 75 cc. (night) | 33 | Flat | Moderate delay in emptying | Excellent relief |
| 3 | Gastric ulcer | | 26/0 60 cc. (night) | 53 | Flat | Atonic stomach; considerable secretion | Good relief early, but persistence of retained secretions |
| 4 | Gastric ulcer | | 20/0 500 cc. (night) | 22 | Downward | Normal motility | Good relief |
| 5 | Bleeding duodenal ulcer | | 10/0 | | | | Retention of 900 to 2,300 cc. 4 to 9 postoperative days |
| 6 | Duodenal ulcer | 64/54 75 cc. | 6/0 141 cc. (night) | 23 | Downward | | Dramatic relief |
| 7 | Duodenal ulcer | 46/24 150 cc. | 40/28 100 cc. | 7 (incorrect) | Upward | | Good relief |
| 8 | Duodenal ulcer | 56/46 115 cc. | 14/0 10 cc. | 76 | Upward | Normal | Good relief |
| 9 | Duodenal ulcer | 60/40 | 20/0 50 cc. | | | Duodenal ulcer, with no crater; normal motility | Good relief |
| 10 | Duodenal ulcer | 64/52 130 cc. | 34/20 450 cc. (night) | 28 | Downward | Considerable secretion in stomach | Good relief |

first reports, in 1814. With the exception of those in the most recent reports, results have been diversified and often conflicting. The extent of the operation has varied in the hands of different workers and the fact must not be overlooked that many workers have employed it in the experimental production of peptic ulcer.⁶ That there is no agreement on even the morphology of the structures of these nerves, let alone their function, is reflected in recent reports in which one author⁷ concluded that the vagus nerve is composed of nothing but sympathetic fibers, whereas two other investigators denied the presence of any sympathetic fibers in the nerve.⁸

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Our anatomic observations were focused particularly on the nerve structures from the pulmonary plexuses to the stomach. The vagi invariably break up into a number of branches immediately below the pulmonary plexus, cross-communicate on the esophagus where they are joined by sympathetic fibers to form the so-called esophageal plexus. In 92 of the specimens from adults studied at necropsy a rather regular pattern was followed in forming

TABLE II
GASTRIC NEURECTOMY PLUS SIMULTANEOUS GASTRO-ENTEROSTOMY

| Case | Type of Gastro-enterostomy | Lesion | Total and Free Acids and Gastric Contents | | Minimal Blood Sugar, Mg. per 100 cc. | Curve of Insulin Test | Roentgenologic Finding | Comment and Results |
|------|------------------------------------|--|---|----------------------------|--------------------------------------|-----------------------|---|---|
| | | | Before Operation | After Operation | | | | |
| 11 | Posterior | Duodenal ulcer, with obstruction | 70/56 375 cc. | 26/16 30 cc. | 32 | Downward | | Excellent relief |
| 2 | Posterior | Perforating duodenal ulcer | 98/88 150 cc. | | | | | Good relief |
| 3 | Posterior | Hemorrhagic duodenal ulcer, with obstruction | 78/66 275 cc. | 10/0 370 cc. | | | Normal | Good relief |
| 4 | Posterior | Perforating duodenal ulcer | 70/54 | | | | | Good relief |
| 5 | Posterior | Perforating duodenal ulcer, with obstruction | 80/68 | 16/0 100 cc. | | | Normal | Good relief |
| 6 | Posterior | Perforating duodenal ulcer, with obstruction | 80/60 | 40/0 60 cc. (night) | 32 | Downward | Gastropasm | Good relief |
| 7 | Posterior | Duodenal ulcer | 46/30 17 cc. | 16/0 600 cc. (night) | 50 | Flat | Normal | Good relief |
| 8 | Posterior | Duodenal ulcer, with obstruction | 78/54 200 cc. | 8/0 13 cc. | 22 | Flat | Dilatation, with retained secretions | Slight fullness with food; good relief of symptoms |
| 9 | Posterior | Penetrating bleeding duodenal ulcer with obstruction | | 34/22 | | | Rapid emptying of stomach; delay in small bowel | Ileus; exploration. 800 cc. retention. |
| 0 | Posterior | Duodenal ulcer with obstruction | 66/54 100 cc. | 22/16 160 cc. | | | Deformed duodenum. Gastro-enterostomy free but high | Retention of 2,000 cc. 4 to 14 post-operative days; recurrence, pain and vomiting |
| 1 | Posterior | Duodenal ulcer | 32/18 500 cc. | 14/0 300 cc. (night) | 45 | Flat | Edema at anastomosis | Slight fullness with meals. Good relief |
| 2 | Anterior; entero-anastomosis later | Duodenal ulcer with obstruction | 69/50 175 cc. | 46/26 | | | Obstruction for 14 days | Obstruction for 26 days; good relief |
| 3 | Anterior | Duodenal ulcer with obstruction | 60/40 | 64/54 200 cc. | | | Considerable retention | Retention of 900 cc. on 4 postoperative days; poor relief |

TABLE III

GASTRIC NEURECTOMY PLUS SIMULTANEOUS GASTRIC OPERATIONS

| Case | Lesion | Total and Free Acids and Gastric Contents | | Minimal Blood Sugar, Mg. per 100 cc. | Curve of Insulin Test | Roentgenologic Findings | Comment and Results |
|---|--|--|---|--|-----------------------------|--|---|
| | | Before Opera- tion | After Opera- tion | | | | |
| Gastro-enteric Anastomosis Disconnected; Ulcer Excised | | | | | | | |
| 24 | Gastrojejunal ulcer | | 20/6 125 cc. (night) | 30 | Flat | Slight deformity duodenal cap; jejunitis in prox- imal jejunum | Excellent relief |
| 25 | Gastrojejunal ulcer | 58/42 200 cc. | 10/0 80 cc. (night) | 43 | Downward | | Excellent relief |
| Gastro-enteric Anastomosis Disconnected; Ulcer Excised; Heineke-Mikulicz Pyloroplasty | | | | | | | |
| 26 | Malfunction- ing stoma, with obstruction | 72/60 55 cc. | 84/50 150 cc. (night) | 30 | Downward | Gastric pyloric spasm | Good relief |
| Gastro-enteric Anastomosis Disconnected; Ulcer Excised; Finney Pyloroplasty Operation | | | | | | | |
| 27 | Gastrojejunal ulcer | 54/40 260 cc. | 60/36 800 cc. (night) | 20 | Downward | Duodenum de- formed by previous ulcer; stomach slightly atonic | Early retention; grad- ual decrease in 4 to 6 days. Good relief |
| Gastro-enteric Anastomosis Disconnected; Anterior Polya Resection | | | | | | | |
| 28 | Gastrojejunal ulcer | 24/10 104 cc. | 6/0 50 cc. | | | Free anastomosis; bowel negative | Good relief |
| Duodenal Ulcer Excised; Gastroduodenostomy | | | | | | | |
| 29 | Duodenal ulcer | 66/48 200 cc. | 22/0 325 cc. (night) | 36 | Flat | | Good relief |
| Biopsy of Ulcer and Cautery | | | | | | | |
| 30 | Gastric ulcer | 12/0 | 22/0 50 cc. (night) | | | | Good relief |
| Transthoracic Exploratory Gastrotomy; Biopsy of Gastric Ulcer; Gastric Closure | | | | | | | |
| 31 | Gastric ulcer and duodenal ulcer | 64/52 | 22/0 800 cc. (night) 11-11-46; 40/26 250 cc. | 45 | Downward | Recurrence of ulcers, but essen- tially normal emptying of stomach | Moderate early reten- tion; poor result. |
| Gastric Ulcer Explored | | | | | | | |
| 32 | Gastric ulcer. Healed duo- denal ulcer | 50/34 180 cc. | 28/0 200 cc. | 45 | Upward then downward | Normal | Good relief |
| Exploratory Gastrotomy Only | | | | | | | |
| 33 | Gastritis | 54/42 380 cc. | 8/0 40 cc. | 76 | Upward | Normal | Good relief |

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discrete nerve trunks below the esophageal plexus. In 64 of these the nerve trunks formed between the esophageal hiatus and 6 cm. above the diaphragm, in 21, at the distance of 6 cm. above the diaphragm, and in seven at the esophageal hiatus. In eight of the dissections, it was impossible to isolate two distinct trunks at any point. In these eight cases the nerves were numerous and communicating, and their distribution did not follow a uniform pattern.

The position of the right and left trunks below the esophageal hiatus was noted in 92 cases, and was found to be remarkably constant. The right gastric

TABLE IV
GASTRIC NEURECTOMY (VAGOTOMY): SIGNIFICANT CASES OF OTHER SURGEONS

| Case | Trans thoracic Approach for: | Free and Total Acids and Gastric Contents | | Minimal Blood Sugar, Mg. per 100 cc. | Curve of Insulin Test | Roentgenologic Findings | Comment and Results |
|------|-------------------------------------|--|---|--------------------------------------|-----------------------|--|---|
| | | Before Operation | After Operation | | | | |
| 34 | Gastrojejunal ulcer | 54/46 185 cc. | 20/0 210 cc. | | | | Excellent relief |
| 35 | Gastrojejunal ulcer | 62/52 100 cc. | 14/0 90 cc. | 37 | Flat | No ulcer. Temporary delay in jejunum | Good relief |
| 36 | Gastrojejunal ulcer | 36/26 105 cc. | 18/0 80 cc. | | | Free anastomosis. No gastrojejunal ulcer | Good relief |
| 37 | Gastrojejunal ulcer | 1944: 112/100 150 cc. 1945: 40/20 100 cc. | 12/0 50 cc. | | | | No pain; slight tendency to diarrhea |
| 38 | Duodenal ulcer | 60/46 130 cc. | 50/28 200 cc. | 38 | Downward | | Good relief |
| 39 | Duodenal ulcer | 78/68 100 cc. | 5-31-36: 26/12 320 cc. 6-1-46: 62/50 150 cc. | | | | Early retention; good relief; considerable eructation |
| 40 | Duodenal ulcer (abdominal approach) | 74/56 150 cc. | 40/20 40 cc. | | | | Early retention. Intermittent vomiting and diarrhea |

nerve, the larger in 54 cases, coursed posteriorly and to the left and then broke up into its branches about 3 to 5 cm. from the hiatus. The largest branch of the right nerve invariably traveled along the left gastric artery to the celiac plexus. The left nerve followed a much shorter course in the abdomen. As it emerged onto the anterior surface of the stomach, it divided into numerous small branches which were lost in the serosa and musculature of the stomach. A branch from both the right and left nerves was invariably found entering the leaves of the gastrohepatic omentum.

From the anatomic standpoint, therefore, it would appear that in a trans-abdominal approach to the gastric nerves the nerves could be located suc-

cessfully in approximately 92 per cent of the cases, and possibly many of the branches in the remaining 8 per cent. In the 33 cases in which one of us (W. W.) resected the vagus nerves (gastric neurectomy) through the transabdominal route, in every case but one it has been possible by exercising care, to find all the gastric nerves, as proved by the Hollander⁹ insulin test.

From the experimental standpoint, I should like to consider several important points. As stated earlier in the paper, an extensive review of the literature reveals that in many instances the early and late effects of gastric denervation in experimental animals have been confused, the results in man have been compared indiscriminately with those in lower animals, and the extent of the operation experimentally, and clinically, has varied in the hands of different workers.

Seventeen years ago, working in the Division of Experimental Surgery of the Mayo Foundation, Hartzell,¹⁰ and Vanzant¹¹ studied the effects of intrathoracic and abdominal section of the vagus nerves of dogs. Hartzell¹⁰ first studied eight animals; on six, intrathoracic vagotomy had been performed and, on two, abdominal vagotomy. The immediate findings revealed total abolition of psychic secretion (cephalic phase), marked and constant reduction in the quantity of free hydrochloric acid and of the total acids and an increase in the hydrogen ion concentration of the gastric secretion. Vanzant¹² studied some of the same group of dogs and an additional group two and one-half years later, and found that in all of the dogs of the original group that she studied the amount of total and free acid had increased five to six months after operation and that free acid was present in all but one of the original group studied two to three years after operation. Eventually, in four of the dogs, curves of free and total acid approach normal. Effects of vagotomy on motility of the stomach were inconstant. Early studies recently reported by Vanzant¹¹ disclosed that in four dogs delayed emptying of the stomach occurred; two dogs had hypermotility with a tendency to diarrhea and emesis, and three dogs had no change in emptying time. Later results¹² showed the motility of seven of ten dogs to be essentially normal. The general health of six dogs was not impaired except for excessive salivation which gradually lessened. Two dogs vomited frequently following the operation. Three dogs had increased appetites in spite of which they lost weight. Of these, two also had a tendency toward diarrhea.

Vanzant's¹¹ comments on these studies were that the psychic phase of secretion seemed to be abolished and the ability of the secretory mechanism to respond to stimuli was decreased. Excessive secretion of mucus was one of the most striking and typical results of vagotomy. She mentioned several possible explanations for the gradual increase of gastric secretion as follows: 1. Regeneration of the severed nerves was considered, but this had not occurred in two dogs on which second operations were performed nor in one dog, as determined at postmortem examination. She assumed, therefore, that regeneration was not an important factor. 2. The possibility that resumption of secretory function was due to stimulation of sympathetic fibers of splanchnic nerves was considered. In three dogs, however, the splanchnic nerves had

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been cut at the time of gastric neurectomy; still, secretion was resumed. She concluded, therefore, that the parasympathetic fibers were not essential in the restoration of gastric secretion. 3. Spontaneous restoration of tone by the autonomous motor and secretory mechanism was the only mechanism she was unable to rule out by her experiments, and she concluded that this mechanism might be responsible for the restoration of gastric acidity. The conclusion which all should draw from this experimental study is that time must elapse before the ultimate results of gastric neurectomy on the secretory and motor activities of the stomach can be determined.

CLINICAL APPLICATION

The Approach and Associated Operations.—The clinical application of these anatomic studies has led one of us (W. W.) to believe that the best approach to the gastric nerves is by an incision in the upper part of the abdomen. The advantage of this approach is that, in addition to permitting abdominal exploration to exclude disease of other organs, it permits examination of the ulcer, its removal if it is a gastric ulcer and is suspected of being malignant, or some type of drainage operation of the stomach if the ulcer is duodenal and obstructive, or if it would appear that obstruction might follow resection of the gastric nerves.

Patients upon whom gastric neurectomy is carried out usually have complicated chronic ulcers which have not responded to many attempts at non-surgical (medical) treatment. If a gastrojejunal ulcer is present which has followed gastro-enterostomy, obstruction not infrequently is present also, as a result of repeated ulceration at the stoma and with the obstruction the previously existing duodenal ulcer frequently is reactivated. In such cases, in addition to gastric neurectomy removal of the gastrojejunal ulcer and the gastro-enterostomy seems necessary, and if obstruction of the duodenum had resulted from reactivation of the duodenal ulcer or from its healing following the gastro-enterostomy, a pyloroplasty seems indicated. In one case in which a recurring ulcer followed a gastric resection, performed elsewhere, perforation of the anastomotic ulcer into the colon was impending. In this case extensive gastric resection seemed indicated together with removal of the anastomotic ulcer, even though gastric neurectomy also was done. It is easy to understand, therefore, why gastric neurectomy has been performed without some other surgical procedure on the stomach of the type mentioned in only ten of the 33 cases in which the operation was performed by one of us (W. W.).

Results.—Since the various surgical procedures on the stomach just mentioned when used without gastric neurectomy in the treatment of patients with ulcers have been followed by relief of pain, decrease of night secretion, reduction of gastric acidity and relief of gastrospasm, the difficulties of determining the effect of associated gastric neurectomy in such cases is evident. This has been true in a study of the 66 patients who have undergone gastric neurectomy during the past year at the Mayo Clinic. Gastric neurectomy has been performed in 23 cases without any other surgical procedure on the stomach (Table V). In this paper it has seemed best to us to

report mainly the results in 33 cases in which one of us (W. W.) performed the operation (Table VI). However, occasionally reference will be made to other cases.

The immediate results in ten of our cases in which resection of gastric nerves was done without other surgical procedures on the stomach have been satisfactory thus far (Table I). Relief of pain, reduction in gastric secretion, reduction of gastric acidity, with early achlorhydria in most cases, and relief of gastrospasm have occurred. However, some interesting complications have occurred in these as well as in the group of 23 in which associated gastric operations were done (Tables II and III). One patient, who had undergone gastric neurectomy only, had sufficient gastric atony and sufficient increase of gastric secretion to require intermittent gastric drainage from the 4th to 9th

TABLE V
GASTRIC NEURECTOMY
CASES AT MAYO CLINIC TO NOVEMBER 1, 1946

| Type of Operation | Total Cases | Duodenal Ulcer | Gastro-jejunal Ulcer | Gastric Ulcer | Gastritis |
|---|-------------|----------------|----------------------|---------------|-----------|
| Gastric neurectomy only..... | 23 | 11 | 10 | 2 | 0 |
| Gastric neurectomy, with gastro-enterostomy.. | 29 | 29 | 0 | 0 | 0 |
| Gastric neurectomy, with excision of ulcer..... | 14 | 4* | 7† | 3* | 1 |
| Total..... | 66 | 44* | 17† | 5* | 1 |

* Both duodenal and gastric ulcer in one case.

† Gastrojejunocolic fistulae in two cases.

day after operation (Table I). In three additional cases moderate retention of gastric secretion was revealed on roentgenoscopic examination; in one, several weeks after operation (Case 3, Table I). In one of 13 additional cases, in which our surgical colleagues at the Mayo Clinic performed gastric neurectomy only, gastric acidity and symptoms of ulcer returned in six weeks in spite of achlorhydria immediately after operation (Table IV). Two patients in that same group have had intermittent diarrhea.

Postoperative disturbances in gastric motility have been troublesome in seven of our 23 cases in which other gastric operations were associated with gastric neurectomy (Tables II and III). Characteristic of three of these, were intermittent paroxysmal abdominal distention relieved by injections of neostigmine. In one of the three cases (Case 19), in which gastro-enterostomy and gastric neurectomy were done, abdominal distention appeared on the 5th postoperative day and increased during the next two days. Roentgenologic studies of the abdomen revealed what seemed to be an obstruction of the small intestine. Exploration revealed ileus; the small intestine was filled with fluid and air or gas, and approximately 800 cc. of sterile straw-colored fluid was found in the peritoneal cavity. Continuous gastric suction by means of an indwelling nasal suction tube relieved the distention and normal intestinal motility returned.

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In four additional cases gastric retention was troublesome for a few days and in all but one of these it subsided within a week. In one case (Case 22) jejunojejunostomy was necessary on the 26th postoperative day to relieve persisting gastric retention. In one case (Case 31), that of a Jew, 67 years of age, a recurrence of a gastric ulcer had taken place, with severe clinical symptoms in spite of a positive insulin test, showing a complete severance of all the gastric (vagus) nerves. An early achlorhydria had been followed by a return of gastric acids.

TABLE VI
GASTRIC NEURECTOMY
AUTHORS' CASES TO NOVEMBER 1, 1946

| Type of Operation | Total Cases | Duodenal Ulcer | Gastro-jejunal Ulcer | Gastric Ulcer | Gastritis |
|---|-------------|----------------|----------------------|---------------|-----------|
| Gastric neurectomy only..... | 10 | 6 | 2 | 2 | 0 |
| Gastric neurectomy, with gastro-enterostomy.... | 13 | 13 | 0 | 0 | 0 |
| Gastric neurectomy, with excision of ulcer..... | 10 | 2* | 5 | 3* | 1 |
| Total..... | 33 | 21* | 7 | 5* | 1 |

* Both duodenal and gastric ulcers in one case.

TABLE VII
COMPLICATIONS FOLLOWING GASTRIC NEURECTOMY IN FIRST 66 CASES (ALL SURGEONS)

| Type of operation | Total cases | Retention | | Cases | Results |
|---|-------------|----------------|----------------|-------|---|
| | | Early clinical | Roentgenologic | | Type |
| Gastric neurectomy only... | 23 | 6 | 6 | 1 | Early pleural effusion; epigastric distress |
| | | | | 1 | Recurrent abdominal pain |
| | | | | 1 | Tendency to slight diarrhea |
| | | | | 1 | Early retention followed by intermittent emesis and diarrhea |
| | | | | 1 | Considerable belching |
| | | | | 1 | Died fourth postoperative day; probably pulmonary embolus |
| | | | | 1 | Died fourteenth postoperative day from perforated duodenal ulcer and subdiaphragmatic abscess |
| Gastric neurectomy with gastro-enterostomy..... | 29 | 8 | 3 | 1 | Died of unknown cause three months after operation |
| | | | | 1 | Recurrent night pain |
| Gastric neurectomy with excision of ulcer or other operation on stomach.... | 14 | 1 | 3 | 1 | |
| | | | | 1 | |

In one of the cases in which gastric neurectomy and gastro-enterostomy were performed by our colleagues, the duodenal ulcer perforated (Table VII). A subdiaphragmatic abscess developed, and the patient died on the 14th postoperative day. In another case in which gastric neurectomy, cholecystectomy and appendicectomy were performed, the patient died following a convulsion on the 4th postoperative day. Postmortem examination was not performed.

Another death from unknown causes* occurred at the patient's home three months after gastric neurectomy for gastrojejunalocolic fistula in which the fistula into the colon was closed at the time of operation.

The gastric acid of one additional patient who had an early relative achlorhydria returned to preoperative level one month after operation and symptoms of ulcer returned. An insulin test was not done in this case.

Gastric acidity and gastric secretion in the cases in which gastric neurectomy alone was performed on our service and some of the other services and in those in which gastric neurectomy was associated with other gastric operations are shown in Tables I to IV and VIII. In many cases in each

TABLE VIII

FREE GASTRIC ACIDITY IN RELATION TO TYPE OF GASTRIC OPERATION (AUTHORS' CASES)

| Type of Operation | Total Cases | Acidity Before Operation | | Acidity After Operation | |
|---|-------------|----------------------------|-------------------|----------------------------|-------------------|
| | | Determinations made, Cases | Mean Value, Units | Determinations made, Cases | Mean Value, Units |
| Gastric neurectomy only..... | 10 | 7 | 30.0 | 10 | 2.8 |
| Gastric neurectomy and gastro-enterostomy | 13 | 12 | 53.2 | 11 | 12.2 |
| Gastric neurectomy and excision | | | | | |
| Gastrojejunal ulcer..... | 5 | 4 | 38.0 | 5 | 18.8 |
| Gastric ulcer..... | 3 | 3 | 20.0 | 3 | 0 |
| Duodenal ulcer..... | 1 | 1 | 45.0 | 1 | 0 |
| Gastritis..... | 1 | 1 | 42.0 | 1 | 0 |
| All cases..... | 10 | 9 | 33.6 | 10 | 9.4 |
| Grand total..... | 33 | 28 | 41.1 | 31 | 8.3 |

group, postoperative studies of gastric motility and roentgenoscopic and roentgenographic examinations were made on approximately the 16th to the 20th day after operation. The temporary changes in gastro-intestinal motility pattern have been described.

Insulin Test.—It is, of course, important in evaluating results of gastric neurectomy to determine whether all of the gastric (vagus) nerves have been divided. Unfortunately, the insulin test, described by Hollander,⁹ involves some risk and must be done only under the constant supervision of a physician who has available a solution of glucose for immediate administration if symptoms and signs of impending hypoglycemic convulsions become manifest. The test itself consists of injection of 10 to 30 units of insulin in order to reduce the patient's blood sugar to 30 mg. per 100 cc. If branches of the gastric nerves are intact, the gastric secretion increases 40 to 50 minutes after injection of the insulin. In 20 of the 66 cases in which gastric neurectomy was performed at the clinic, the Hollander insulin test has been carried out. Results are shown in Tables I to IV. In all but one of our 33 cases (W. W.) no elevation in gastric acidity occurred (Tables I to IV).

* Death due to heart disease reported by home physician.

GASTRIC NEURECTOMY FOR ULCER

We are indebted to Drs. Fitzgibbons, Watts, McVicker, Brownson, Lowe and Lyman for assistance in reviewing and abstracting the records, and tabulating the results.

Case 31.—A Jew, age 67, gave a history of having had peptic ulcer for 36 years. Posterior gastro-enterostomy was performed in July, 1927, for a small duodenal ulcer. Shortly after operation, intermittent attacks of abdominal pain of ulcer type began. A gastrojejunal ulcer was demonstrated on roentgenologic examination on several occasions, and medical treatment was given without relief.

Symptoms of ulcer became more severe in April, 1946. Roentgenologic examination revealed a large perforating gastric ulcer on the lesser curvature of the stomach just below the esophagus and a duodenal ulcer. In June, 1946, the gastro-enteric anastomosis was disconnected and the gastrojejunal ulcer was excised. The scar of a healed duodenal ulcer, 4 mm. in diameter, was found on the anterior wall of the duodenum but there was no duodenal deformity. The posterior duodenal wall was soft. Transabdominal

TABLE IX
RESULT OF INSULIN TEST IN CASE 31

| | Fasting | Time After Injection of Insulin | | | |
|----------------------------------|---------|---------------------------------|----------|----------|----------|
| | | 15 Mins. | 30 Mins. | 45 Mins. | 60 Mins. |
| Blood sugar, mg. per 100 cc..... | 103 | 89 | 68 | 48 | 45 |
| Total acid, units..... | 26 | 12 | 12 | 10 | 10 |
| Free acid, units..... | 10 | 0 | 0 | 0 | 0 |
| Amount of secretion, cc..... | 30 | 10 | 15 | 35 | 40 |

gastric neurectomy seemed to be contraindicated at this time because of the location of the perforating ulcer. In order to perform this operation the ulcer would have had to be separated from the pancreas. The high location of the ulcer would have made its removal and accurate closure of the opening in the stomach difficult and hazardous. It was decided that resection of the stomach to remove the ulcer would have necessitated removal of most of the stomach. Since the patient's general condition did not permit a resection of this magnitude, medical regimen seemed indicated. A six-weeks' trial of medical treatment did not give relief of the pain. The gastric ulcer did not decrease in size and a duodenal ulcer, with a crater, was found on roentgenologic examination. Trans-thoracic resection of the gastric nerves was performed on July 9, 1946. One major and one minor anterior nerve and one major and one minor posterior nerve were resected. Incision was made through the diaphragm. Part of the gastric ulcer was excised for microscopic examination and proved to be inflammatory. The opening in the stomach was closed. Subsequent to operation, the patient complained of pain along the thoracic incision, and within two to three weeks pain of ulcer returned. September 18, 1946, a Hollander insulin test was performed with the results shown in Table IX.

The patient has continued to have symptoms of ulcer, regardless of the strict medical regimen carried out in the hospital. Roentgenologic examination on November 13, 1946, showed the gastric ulcer to be practically the same size as prior to operation. Gastric analysis on November 11 revealed 26 units of free hydrochloric acid, with a combined acidity of 40 units. There was 250 cc. of gastric secretion. Resection of the stomach was done on January 13, 1947. The ulcer was 2.5 cm. in diameter and benign.

COMMENT: Dragstedt's first gastric neurectomy in treatment of gastric disease was performed three and one-half years ago, and that of Moore and

Chapman more than two years ago. Since their first operations these surgeons have treated other patients in this manner, most of whom have been benefited. Yet, because of experimental evidence that any change may be only temporary and because long experience with peptic ulcer makes us reserve judgment of any operation until a large series of cases has been collected and a period of many years has elapsed, gastric neurectomy at present, at the Mayo Clinic, is being performed only in selected cases of peptic ulcer. We think the final report on this operation is not due for some years and that all reports now, and for some years to come, should be considered interim reports. In the meantime, the procedure can be used in the following group of cases:

First, in cases of recurring ulcer after an adequate gastric resection, it seems justifiable to undertake the comparatively simple operation of gastric neurectomy on the chance that the ulcer will heal and symptoms will be relieved.

Second, the operation may be used in certain cases of gastric ulcer in which excision of the ulcerating lesion is necessary to exclude the possibility that it is malignant. Microscopic examination is made immediately to eliminate the possibility that the ulcer is an ulcerating carcinoma. Then the gastric neurectomy is performed.

Third, the operation may be undertaken in certain cases of obstructing duodenal ulcers associated with high gastric acidity. Simultaneous gastro-enterostomy is performed to relieve the duodenal obstruction. It will be interesting to determine whether the incidence of recurring ulcers will be less than in cases in which gastro-enterostomy without gastric neurectomy is performed.

A fourth group consists of cases of chronic, nonobstructing duodenal ulcer, in which the cephalic phase of the hyperacidity seems to overshadow other factors and no response has been obtained from repeated courses of medical treatment. In these cases we believe gastric neurectomy may be justified. Many of these patients are young and have high values of gastric acidity and active duodenal ulcers which respond unsatisfactorily to medical treatment. The behavior pattern in these cases suggests a prolonged and excessive nervous phase of gastric secretion.

SUMMARY AND COMMENT

A study of the anatomy of the gastric nerves has demonstrated that in 92 per cent of the cases the nerves pass through the diaphragm as two distinct trunks and are readily accessible for resection.

The abdominal approach to the gastric nerves allows exploration of the abdominal contents and especially the ulcer, removing it if it is a gastric ulcer and is suspected of being malignant, and performing a drainage operation of the stomach if the duodenal ulcer is obstructive or likely to become obstructive from gastric atony.

It is important to remember in our series of 33 cases that the disturbances of gastro-intestinal motility were, for the most part, temporary. Although

spasm of the pylorus with dilatation of the stomach and hypermotility of the intestine has persisted for several weeks in one patient operated upon for gastric ulcer. In one case gastric ulceration definitely recurred. In the entire series of 66 cases, perforation of a duodenal ulcer and a subdiaphragmatic abscess caused the death of the patient 14 days after gastric neurectomy and gastro-enterostomy, and two other deaths occurred, one from a suspected cerebral embolism on the 4th postoperative day and the other at home from a heart lesion. This patient had had a gastrojejuno-colic fistula closed and gastric neurectomy three months previously. In the other cases the immediate results, as evidenced by reduction in gastric acidity, gastric secretion, relief of gastro-spasm and relief of pain, were good but not striking. If the good results will persist, the operation offers an easy and a comparatively safe method of treating certain cases of peptic ulcer, especially cases of recurrent ulcers. It will have a limited application in cases of obstructing duodenal ulcer and in certain cases of gastric ulcer. In the former, it can be used in a few cases in association with gastro-enterostomy. In cases of gastric ulcer excision of the ulcer should be done to exclude malignancy. When excision of the ulcer and gastric neurectomy have been done simultaneously, disturbances in gastric motility, with retention and higher secretion, have been troublesome. In any case, however, sufficient time must be allowed to pass to determine whether the good results are temporary as they seem to be in experimental animals and whether untoward results may develop.

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REFERENCES

- ¹ Dragstedt, L. R.: Vagotomy for Gastroduodenal Ulcer. *ANNALS OF SURGERY*, **122**, 973-989, December, 1945.
- ² Grimson, K. S., Taylor, H. M., Trent, J. C., Wilson, D. A., and Hill, H. C.: The Effect of Transthoracic Vagotomy upon the Functions of the Stomach and upon the Early Clinical Course of Patients with Peptic Ulcer. *South. M. J.*, **39**, 460-471, June, 1946.
- ³ Moore, F. D., Chapman, W. P., Schulz, M. D., and Jones, C. M.: Transdiaphragmatic Resection of the Vagus Nerves for Peptic Ulcer. *New England J. Med.*, **234**, 241-251, February 21, 1946.
- ⁴ Miller, Edwin: Personal communication to the authors.
- ⁵ Brodie, B. C.: Quoted by Hartzell, J. B.¹⁰
- ⁶ Beaver, M. G., and Mann, F. C.: The Production of Peptic Ulcer after Section of the Gastric Nerve. *ANNALS OF SURGERY*, **94**, 1116-1118, December, 1931.
- ⁷ Kiss, F.: The Relation between Vagus and Sympathetic in the Vertebrates. *J. Anat.*, **66**, 153-156, October, 1931.
- ⁸ McSwiney, B. A., and Spurrell, W. R.: The Gastric Fibres of the Vagus Nerve. *J. Physiol.*, **77**, 447-458, March 15, 1933.
- ⁹ Hollander, Franklin: Discussion. *Gastro-enterology*, **3**, 466-467, December, 1944.
- ¹⁰ Hartzell, J. B.: The Effect of Section of the Vagus Nerve on Gastric Acidity. *Am. J. Physiol.*, **91**, 161-171, December, 1929.
- ¹¹ Vanzant, Frances R.: Late Effects of Section of the Vagus Nerves on Gastric Acidity. *Am. J. Physiol.*, **99**, 375-378, January, 1932.
- ¹² Vanzant, Frances R.: The Late Restoration of Gastric Acidity after Thoracic Vagotomy in the Dog. Unpublished data.

DISCUSSION.—DR. ARTHUR W. ALLEN, Boston, Mass.: This presentation to which you have just listened is very interesting to me. Doctor Walters approaches the problem in a different manner from what we have done at Massachusetts General Hospital. When I read the title of his paper I was considerably perturbed that he had included gastric ulceration in his subject. It has been a great consolation to me that he reports one recurrence in five instances of gastric neurectomy for gastric ulcer. I feel this may help us tremendously in preventing the stampede in the direction of applying this approach to cases that should be subjected to more radical types of surgery. Gastric ulcers are admittedly satisfactory from a surgical standpoint. Furthermore, the mortality rate in gastric resection for gastric ulcer is lower than for any other lesion of the stomach.

It is very difficult to get the medical profession to accept the fact that a gastric ulcer that does not respond completely to conservative treatment may be malignant. We reported before this Association a few years ago our analysis of a group of gastric ulcers diagnosed as benign, and in that series 14 per cent proved to be carcinoma. If we are to improve our results in this terrible disease, that takes such a high toll of life each year, we must insist on a radical attitude in gastric ulcer.

We have taken out more of the nerves than is shown in Doctor Walters' beautiful movie, but all our neurectomies have been done transthoracically. We have had excellent results in nonobstructing duodenal ulcer cases. They do get stasis after operation, but we find this is not a serious problem. We have not combined this operation with other procedures such as gastro-enterostomy, because we feel that we must give vagus resection itself a fair trial. The results so far have been spectacular in nonobstructing duodenal ulcers and in anastomatic ulcer. There were two temporary failures in anastomatic ulcer; they had been operated elsewhere, and, supposedly, had had a classic subtotal resection. However, when their anastomatic ulcers failed to respond to vagus resection, abdominal exploration revealed that the antrum of the stomach had been left *in situ* at the time of their original operation. In both cases the anastomatic ulcer healed after removal of the remaining pyloric segment.

Dr. F. D. Moore, in our hospital, has carefully evaluated these patients before operation and followed them afterward. He has done most of these procedures in our clinic so far, and has reported the results in detail.

DR. R. L. SANDERS, Memphis, Tenn.: Before undertaking vagotomy I went to Chicago to observe Doctor Dragstedt's work. If peptic ulcer is neurogenic in origin, as it undoubtedly seems to be, his operation is on solid ground.

After seeing Doctor Dragstedt perform vagotomy transabdominally, I tried the same procedure on cadavers, then opened the chest. I found we had succeeded in dividing all nerve trunks through the abdomen. We have, therefore, employed no other approach in any of our cases, preferring to determine the nature and extent of the disease before deciding upon the type of operation.

The esophagus is easily approached if one first mobilizes the left lobe of the liver by division of its triangular ligament. It is advantageous to leave the tube in the stomach as a guide; one can, thus, easily locate the esophagus. By drawing the esophagus down three inches, the nerve trunks are placed under tension and may be divided between clamps. About two and one-half inches of the nerve may then be resected. Like Doctor Walters, we have found the right nerve the larger of the two in most cases.

We have employed vagotomy for 13 duodenal ulcers and two gastrojejunal ulcers, a total of 15. In seven of the 13 duodenal ulcer cases we have added a gastro-enterostomy because of obstruction. The results in these seven and the two who had a gastrojejunal ulcer have been most satisfactory. The patients who had vagotomy alone have continued to have a mild degree of distention and have had to observe some dietary restrictions. No doubt these after-effects will clear up as the tonus of the stomach improves and the inflammatory reaction about the pylorus subsides. One can never tell, however, whether the tonus will return to normal or how much obstruction will persist. This is, likewise,

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true of the acids. If vagotomy keeps the acids from rising again, we have no fear of further trouble from this source. We are inclined to think that the acids will remain low so long as the motility does not become excessive.

Unquestionably, the risk of vagotomy is much less than that of resection. It seems, moreover, that we will be able to give patients better stomach function with less danger of nutritional deficiencies. Doctor Dragstedt is to be congratulated upon his introduction of the procedure. From his own results after a period of approximately four years, it is an outstanding achievement in ulcer treatment from the standpoint of symptomatic relief, as well as of simplicity and safety.

DR. R. ARNOLD GRISWOLD, Louisville, Ky.: My experience with resection of the vagus nerves has been limited to not quite 30 cases. The results have been very favorable—so much so, that I am afraid there is danger of us all becoming overenthusiastic, and developing the tendency to cut the vagi for every "bellyache." In all my cases of ulcer, there has been healing of the ulcer and dramatic relief of pain. In only one case has a drainage operation (gastro-enterostomy) been necessary after vagotomy. In five of the other cases pyloric obstruction was recognized prior to vagotomy and a complementary drainage operation performed.

I do not think the approach makes a great deal of difference. Transthoracic approach is easier for me and, I feel, easier on the patient than the transabdominal approach. A good deal depends on whether the surgeon has an anesthetist who is familiar with thoracic surgery.

Of course, in all cases of questionable diagnosis, the approach should be transabdominal. I do not believe the operation should be undertaken on any gastric ulcers. In one of my cases, performed transabdominally, my gross diagnosis was benign gastric ulcer. Later, the patient died of a lymphosarcoma of the stomach. Another case, with which I am familiar, was explored by a competent surgeon, and a frozen section was taken, with the report of benign ulcer. Vagotomy was done and when the permanent sections came through, the diagnosis of carcinoma made resection imperative. Doctor Allen has brought out the number of gastric carcinomas which may be overlooked, even at the operating table, so that until we have better means of making the diagnosis of carcinoma, vagotomy should be reserved for duodenal or gastrojejunal ulcers.

SLIDE I: This slide shows the average 12-hour night secretions before and after vagotomy on 17 patients—a total of 53 tests. Before vagotomy, the average 12-hour volume of gastric secretion was 1,300 cc., with free acidity of 45 degrees. After vagotomy, an average volume of 270 cc. with free acidity of one degree was observed.

SLIDE II: This roentgenogram indicates the result of vagotomy following an improperly performed gastro-enterostomy. This patient had a gastrojejunal ulcer resulting from a gastro-enterostomy, performed elsewhere, several years ago. In addition, there was complete pyloric obstruction. As you see, the gastro-enterostomy is far to the left on the great curvature. Following vagotomy, the atonicity of the stomach caused the tremendous dilatation of the antrum, which you see. This was accompanied by marked stasis, fermentation and putrefaction of retained food in the stomach. He has since obtained complete relief following a Finney pyloroplasty. For this reason, whenever a drainage operation is necessary because of pyloric obstruction, it should be either a pyloroplasty or a gastro-enterostomy as near the pylorus as feasible.

DR. EDWIN P. LEHMAN, Charlottesville, Va.: At the University of Virginia Hospital a single recent experience suggests a use for vagotomy which has not been discussed this morning; namely, vagotomy for the relief of pain associated with gastric or other intra-abdominal cancer. At transthoracic exploration for a supposed chronic perforation of a gastric ulcer, a huge mass was encountered which was thought to be inflammatory. While awaiting the result of a frozen section taken from the edge of an ulcer, vagotomy was done. When the report of cancer was obtained, the diaphragm and chest were

closed, since the lesion was inoperable. The patient had had persistent severe abdominal pain preceding operation. Following operation the pain disappeared completely. The vagotomy was performed by Dr. Edward V. Siegel, Resident Surgeon, under the direction of Dr. William R. Sandusky, of the Visiting Staff.

This experience, also, may have a fundamental bearing on the relief of pain following benign ulcer of the duodenum. In future explorations, in which inoperable gastric cancer is encountered, we intend to carry it out, if possible, as a routine measure, and suggest that others do the same.

DR. FRANK H. LAHEY, Boston, Mass.: This is a situation which is now very similar to many we have been through before. We all know them—gastro-enterostomy, total thyroidectomy, bone plates, total colectomy, and any number of other problems. We have to remember, in relation to gastro-enterostomy alone, the enthusiasm with which it was supported, and the arguments over the percentage of complications. We have to remember that it took 20 years to truly assess the position of this operation, which made many of us reverse our position from that taken earlier in our experience.

This is not a condemnation of vagotomy, but is merely to warn against the over-enthusiasm, with which we frequently are likely to promote something in which we are deeply interested. Recall some of the consequences of this overenthusiasm for total thyroidectomy, and how completely without value it was.

Vagotomy is, however, not at all like total thyroidectomy. It really accomplishes something which is very desirable, particularly in patients with duodenal ulcer. It diminishes acidity, it diminishes hypersecretion, and it diminishes motility. Because the operation is still an unseasoned one, but because we have such a large number of patients with ulcers with which to deal, it is necessary for us to take a position on it, which is as follows: We would, if possible, like to limit vagotomy in patients with duodenal ulcers to those patients in whom another operation, such as gastro-enterostomy, will not have to be done. The reason we would like to limit this operation to this type of case, if possible, is that if many of these patients have both vagotomy and gastro-enterostomy it will not be possible to determine to which procedure a good result can be ascribed. In our opinion, this will serve only to confuse the situation. We realize that this will be difficult to attain because of the fact that in so many of the patients with very bad duodenal ulcers in whom surgery is indicated, some degree of pyloric obstruction will be produced when the ulcer heals, and that this will be further augmented by the atony which is associated with a vagotomy. We would like, because of this, to do all cases of this type when possible transthoracically because of the completeness of the removal of the various branches of the vagi at this level.

In performing, now, 97 total gastrectomies, we have become very familiar with the infradiaphragmatic distribution of the vagi, because it is impossible to undertake total gastrectomies without finding the vagi, putting them on the stretch, and severing them.

The thing I do not particularly like about vagotomy, either supradiaphragmatic or infradiaphragmatic, is the number of drainage operations which have to be done with it. This can be particularly undesirable if at a later period it can be demonstrated that there will be a return of high gastric acidity in some of these cases, because we will again be having to deal, as we have in the past, with gastro-enterostomy, with a considerable number of gastrojejunal ulcers and gastrojejunal fistulae.

We would, particularly, not like to undertake this operation upon patients with gastric ulcers. I have personally taken a position with regard to gastric ulcers which is contrary to the one I have maintained in the past; that is, that all gastric ulcers should be removed. I wish to take this position because of the danger of malignant change in some of them, and because of the fact that it is impossible for anyone, except the pathologist, in some of these borderline cases, to tell whether or not malignancy is present in the ulcer. Some of these patients upon whom subtotal gastrectomy for gastric ulcers under these circumstances would be done, would undoubtedly get well on medical

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treatment alone, but since, as already stated, pathologists cannot separate the malignant from the benign ulcer, since the five-year nonrecurrence figures in cancer of the stomach are as bad as they are and, since, in addition, the mortality of subtotal gastrectomy for gastric ulcer in inexperienced hands has largely been abolished, I think that neither vagotomy nor medical treatment should be applied in patients with gastric ulcer. I am bound to say, however, that our Gastro-enterologic Department does not entirely agree with me in regard to 100 per cent surgical treatment of these lesions. I feel sure they agree with me, however, that vagotomy should not be applied to patients with gastric ulcer.

It is very nice to have another operation of this type which can be applied to the patient with duodenal ulcer, but it is wrong to assume that this is the complete answer to the problem. Our position regarding it, therefore, is that if we have a patient who has had a subtotal gastrectomy and he, or she, then has a jejunal ulcer, since this is such a complicated operative procedure at this stage and since this stomach will drain well anyway, we will unhesitatingly apply transthoracic vagotomy to this type of patient. We know that some of our patients with subtotal gastrectomy for ulcer do have gastro-jejunal ulcers, probably about 5 per cent. We know, in addition, that some of our patients operated upon for duodenal ulcer who have had high subtotal gastrectomies bleed after the subtotal gastrectomy. We have, therefore, combined infradiaphragmatic vagotomies with our subtotal gastrectomies with the hope that this will diminish the number of jejunal ulcers and bleeding after adequate subtotal gastrectomies for duodenal ulcers.

We must keep our minds open on this subject. It is fine that University Clinics can undertake them, but for us, who have to deal with private patients, many of them in the charity group, but who still take the position that they do represent private patients, it is necessary for us to take a middle-of-the-road position, having in mind always the uncertainty at a later date of the results of these vagotomies and the associated gastro-enterostomies which have to be done with them. We are quite willing to limit our experiences with this operation to the above group until it has been employed in a larger number of cases, over a greater number of years.

DR. WALTMAN WALTERS, Rochester, Minn. (closing): I should like to thank the gentlemen who discussed my paper. I agree with them, heartily, that gastric resection (partial gastrectomy) is the best surgical method of treating chronic gastric ulcer. I am particularly happy to have Doctor Lahey say that he is of the same opinion. For 20 years we have advocated the practice of resection of the stomach in treatment of chronic gastric ulcer and have carried out such practice in approximately 60 per cent of such cases seen at the Mayo Clinic. In contrast, the incidence of surgical treatment of duodenal ulcers has decreased to about 12 per cent of those found in the clinic. When one operates in only 12 per cent of cases he is operating, then, only on patients with complicated duodenal ulcers, such as those that are causing bleeding, perforation, obstruction or impending obstruction. Therefore, since in the latter conditions operation upon the stomach to provide for drainage will be required sometimes, it is much better to provide for such drainage at the time of gastric neurectomy than to perform a secondary operation a few weeks, or months, later.

I do not agree that gastro-enterostomy is an obsolete operation. Some of the best results I have seen in the treatment of duodenal ulcer are in cases in which gastro-enterostomy has been performed, and jejunal ulcers have not developed. In cases in which the type of operation was properly chosen and properly performed we have not seen recurrences in more than 4 per cent. As a matter of fact, Hans Lorenz, of Vienna, who first advocated use of gastric resection routinely in treatment of duodenal ulcer, told me that in his own experience he had never seen recurrences of duodenal ulcer in more than 10 per cent of cases after gastro-enterostomy had been performed in a proper manner. These operations had been performed on central Europeans whose nutritional state from 1918 to 1930 had been rather poor.

I should like to concentrate attention on the terminology we should all adhere to. The term "vagotomy" is not descriptive of the operation in which a section of the vagus nerve is removed. I think a better term would be either "gastric neurectomy" or "vagus nerve resection." Although I think it makes little difference whether the approach is made above or below the diaphragm in isolation of the vagus nerves, I prefer the subdiaphragmatic approach because it permits exploration of the lesion and abdominal contents. In all but one of my cases the approach has been from below the diaphragm. The findings in anatomic dissections seem to indicate that the operation can be done just as well from below the diaphragm as from above in at least 92 per cent of cases. In the 8 per cent of cases in which there are not discrete nerve trunks but multiple branching nerves, I think the best approach might be from above the diaphragm.

We should concentrate our thought on cases in which gastric neurectomy, not associated with other surgical procedures, has been performed in order that we may get the data required for adequate study and evaluation of the procedure.

CARCINOMA OF THE COLON*

EFFECT OF RECENT ADVANCES ON THE SURGICAL MANAGEMENT

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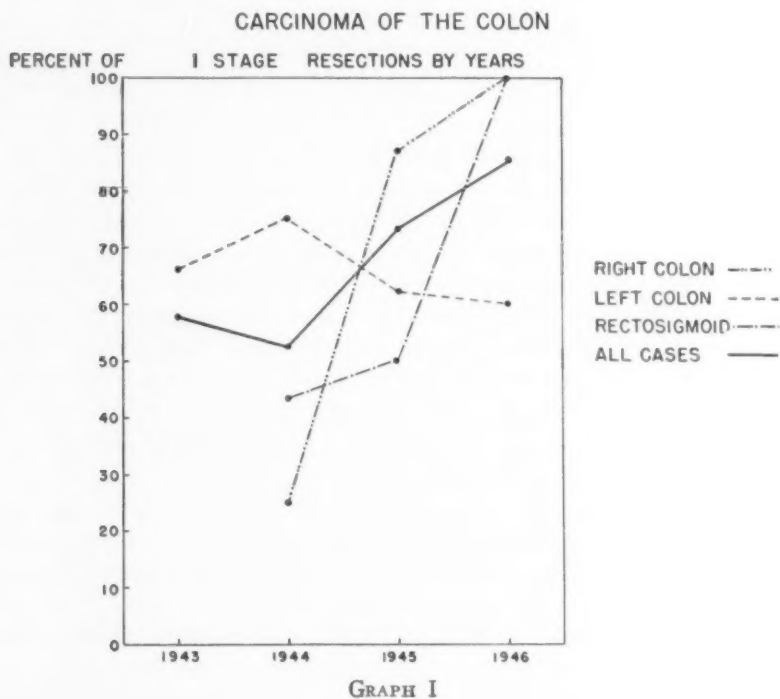
IN THREE PREVIOUS REPORTS,¹⁻³ we have discussed the management of cancer of the large intestine. These have reviewed our personal experience in this field of surgery and outlined the methods of preparation and operation that seemed, at the time, to offer the best chance for a favorable outcome. It is now our intention to present the data on 105 additional patients observed and treated since January 1, 1943. With advances in the preparation of patients for operation; better anesthesia; changes in surgical technic; and more physiologic after-care and experience, there has come about a naturally-expected improvement in immediate results. It is not our intention to discuss, in this communication, carcinoma of the rectum that because of location and extent has required combined abdomino-perineal operations. We will, however, include all cases which have been operated upon by the abdominal approach only, in spite of the fact that some of these with pelvic anastomosis would have been subjected to a combined procedure in our earlier reports. Actually, some of these high rectal, rectosigmoid, and low sigmoid lesions will be considered in this paper in one group and only those needing complete extirpation of the rectum excluded.

We have been disturbed by the trend of the times, indicating a great revival of interest in operations upon the rectum that include preservation of the anal sphincter.⁴ This tendency is growing, and is the natural result of two main factors. One is the work of Gilchrist and David,⁵ and that of Collier, *et al.*⁶ Both groups having demonstrated that the initial spread of disease from the rectum and low colon is cephalward. It may be possible that when the spread of disease ceases to be in a cephalward direction that cure is unlikely. That we may safely have a shorter distal segment of normal tissue than is necessary on the proximal side is now accepted by all, since the lymphatic spread is so intimately associated with the blood supply to the region. It is obvious that surgeons, who have had considerable experience in this field, may well select their cases properly from the standpoint of the type of operation suitable, or justifiable, under given circumstances.

The second influence is the advancement in operative technic, preparation, and after-care. This leads to immediately-successful, though difficult procedures. However, one should emphasize the importance of cure rather than the relatively unimportant preservation of the sphincter. Our only

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reason for bringing it into this discussion at all is to warn the enthusiastic, skillful, young surgeon that time will be needed to evaluate some of these procedures. We do know that local recurrences take place and that some of these might have been prevented if a complete operation had been undertaken. Also, it must be borne in mind that permanent colostomy is not incompatible with comfort and a normal life. The operation of Miles has become so standardized that, now, the risk is incredibly low. In 100 consecutive patients admitted to the wards of the Massachusetts General Hospital with cancer of the rectum, 72 were resectable and, of these, only two

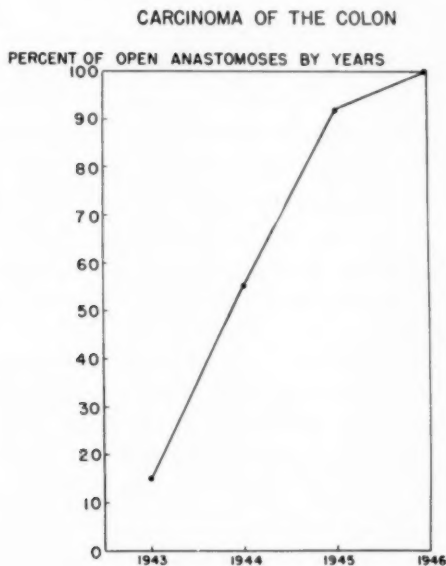


failed to survive. Inasmuch as most of these operations were done by the resident staff, this mortality rate of less than 3 per cent is all the more striking. At this time, it seems obvious to us that the safety of this procedure with its applicability to contact spread of the disease should be taken into consideration in the selection of operation.

In the General Hospital, we² found that the ratio of admissions with carcinoma of the rectum to carcinoma of the colon was 2 to 1. This is not a true picture of the problem in our community, or according to vital statistics in the country at large. It appears that during the past three years, at least,

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we have received into the private wards a reverse of this ratio. Perhaps, this may be influenced to some extent by a greater number of low anastomoses but, on the whole, may reflect somewhat on the type of the referring physician and the circumstances of the patient. A few years ago, it was apparent that more surgeons in this locality felt themselves competent to cope with carcinomas of the colon than with those requiring a combined operation. It seems obvious that this situation would, in time, change. Now, many of our patients with advanced disease of the colon and rectum have been explored and then referred to us if the extent of the process appeared formidable and the problem complex. Doubtless the fatalistic attitude concerning cancer of the bowel, formerly held by the layman, and too often



GRAPH II

accepted by the physician, is changing to a more hopeful outlook. It is discouraging, however, to find little evidence that much has been accomplished regarding earlier diagnosis. The average duration of symptoms in the group of carcinomas of the rectum referred to above was seven months.

RESECTABILITY

In our last report,³ we favored the term resectability to that of operability. Inasmuch, as many of these lesions require the removal of adjoining structures with widespread local extensions or even liver metastasis where cure is impossible, it seems now that such an attitude is even more justifiable. The more advanced the lesion, the poorer the operative risk. On the other hand, it is incredible that the extent of some of these resections, including many

contact organs, is compatible with immediate success. Occasionally the respite is a short one but frequently it is of years duration. The physical and mental comfort to the patient is definitely worth the effort expended. Palliative procedures that fail to remove the primary lesion are much less satisfactory, although we question the effect on regression of metastatic disease by removal of the primary focus.

In our previously reported series, the resectability rate was 91 per cent. In the present group, it was 95 per cent. This indicates that perhaps we have been fortunate in the effect of earlier diagnosis to some extent in our community. However, the large number of cases with extensive disease is discouraging. We do not believe that we have included a greater number of resections of adjacent contact structures in this group than in the former.

MORBIDITY

The period of invalidism following colon resections is dependent on many factors. In spite of the often two-stage attack that is necessary in the presence of acute obstruction, the final resection followed by primary anastomosis has been more satisfactory in our hands than exteriorization procedures. Although advocates of Mikulicz's type of operation with their increased experience have met the situation with a reasonable mortality rate, the actual number of hospital days has usually been increased. It is interesting that frequent reports are now appearing, suggesting a more widespread adoption of primary anastomosis.

Previously, we have felt that proximal decompression, either before or at the time of primary anastomosis, was an additional safeguard to the patient. Since the introduction of the Miller-Abbott tube and the use of sulfasuxidine and sulfathalidine in the preparation of patients for colon resections, fewer have needed cecostomy. We still use it in acute complete obstruction and, on occasion, supplement this procedure with complete transverse colostomy. This latter type of decompression is particularly adaptable to extensive inflammatory reaction about the initial lesion. Although rarely necessary in preparation of patients with cancer of the left colon, it is justifiable in doubtful cases and is essential in diverticulitis with obstruction or abscess formation.

When staged procedures of any kind are done, the convalescent period must include all the necessary hospital days whether or not there is an interim at home before the final closure of the temporary decompression. Tube cecostomies, such as we use, heal spontaneously in most instances. We feel, however, that complete colostomies are best handled by final excision of all scar tissue and an accurate end-to-end anastomosis with the bowel dropped free into the peritoneal cavity. Closure of colostomies within the abdominal wall has not been popular in our clinic; even if successful, the patient often complains of discomfort where the bowel is fixed in the abdominal wall. This is particularly true of the transverse colostomy most often used by us. It is of interest that exact anastomosis of the transverse colon, replaced within the peritoneal cavity, has not resulted fatally in any case in our hands.

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MORTALITY

Deaths following operations upon the colon that occur in the hospital have been taken as the basis for determining the operative mortality. Inasmuch as many of these patients are aged and depleted from other diseases, there will of necessity be deaths from causes unrelated to the operative procedures. These however must be included, since few of these patients have nothing else the matter with them and, if unrelated deaths were excluded, there would be no sound basis on which to determine our immediate results. With the increasing advances in our knowledge concerning the physiologic principles upon which life depends, there has been a steady decrease in operative mortality. The added benefits of chemotherapy have doubtless played a rôle, but we believe too much credit has gone in this direction.

TABLE I
CARCINOMA OF THE COLON

| Years | No. of Cases | Resectability % | Resection Mortality % |
|----------------|--------------|-----------------|-----------------------|
| 1925-1942..... | 143 | 91 | 17.5 |
| 1943-1946..... | 105 | 95 | 2.0 |

TABLE II
CARCINOMA OF THE COLON

| | 1943-1946 | No. of Cases | Deaths |
|--------------------|-----------|--------------|--------|
| Resections | | | |
| For cure..... | | 87 | 0 |
| Palliative..... | | 13 | 2 |
| Nonresectable..... | | 5 | 2 |
| | | 105 | 4 |

Carefully controlled anesthesia, blood replacement, and better technical surgery, have really been the chief reasons for better results in our opinion. It is incredible how much surgery these depleted, aged patients with numerous complications will stand if properly supported.

In our previous series of resectable lesions, the over-all mortality rate was 17.5 per cent. In the present group of 100 patients two failed to survive a resection, a mortality rate of two per cent. Divided into groups of those with right and proximal transverse carcinomas one died, and of the left colon lesions two died. Two of the five nonresectable lesions, both in the left colon, failed to survive. During this interim 38 additional patients were subjected to abdomino-perineal resections for cancer, with one death. An additional 37 colectomies were performed for inflammatory processes, with two deaths. The improvement in results lead us to certain deductions relative to the preparation of the patient, the type of anesthesia, details of the operative procedure, and the after-care. Various modifications of routine measures were necessary according to the situation found.

PRELIMINARY PROCEDURES

In the presence of acute obstruction, one has little time to improve the patient's condition until this feature has been overcome. In cancer of the right colon, obstruction usually comes as a late manifestation, and more often represents an inoperable situation. These are, however frequently associated with an incompetent ileocecal valve and, in a few instances, with intussusception in an otherwise easily resected tumor. Decompression by the Miller-Abbott or Harris tube is often effective enough under these circumstances to allow an early attack on the site of involvement. When the plain film of the abdomen reveals dilated coils of small intestine, one may reasonably expect the long tube to produce adequate preliminary drainage. If this fails, or if the distention is not proximal to the cecum, then an early ileotransverse colostomy is indicated. This, we believe, is best done in continuity and, since the bowel cannot be previously prepared, should be accomplished by an aseptic technic. It is important to select as points for the anastomosis, the ileum 12, or more, inches proximal to the ileocecal valve and the midtransverse colon.

When the obstructed segment is in the left half of the colon, we believe that the safest and most effective immediate relief comes with a large tube cecostomy. Frequently such a procedure must be done as an emergency, since the cecum becomes avascular from prolonged distention and ruptures through a gangrenous spot, producing a fatal peritonitis. A suction trochar is effective in releasing enough gas and liquid contents to allow the semi-collapsed cecum to be exteriorized sufficiently for completion of the cecostomy without peritoneal contamination.

Rarely does one find the patient's condition suitable for an attack on the primary lesion in the presence of complete obstruction. We have occasionally accomplished complete transverse colostomy when this segment was not too distended and when the diagnosis between cancer and diverticulitis was not clear. Exteriorization procedures in the presence of complete acute obstruction are to be condemned. The patient is not in condition to withstand the necessary dissection for an adequate cancer operation under these circumstances.

Explorations of the abdomen in the presence of acute large bowel obstruction are dangerous. Manipulation of the obstructed lesion will often result in fatal peritonitis. It should be emphasized that if a decompression is decided upon at exploration, it should be accomplished as far from the field of final attack as possible. Too many cecostomies have been established in the midline or even in the left side of the abdomen.

On admission, a patient with suspected cancer of the colon should have the following studies in addition to a careful physical examination and history. A plain film of the abdomen will often reveal the approximate site of the lesion by the gas-pattern. This is particularly true when obstruction of any degree is present. If this fails to give a lead, one should then proceed with a careful sigmoidoscopy. Failing to visualize the lesion, barium enema must be resorted to, with complete understanding of the problem by the Roentgenol-

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ogist. The ease with which barium may flow from below through an obstructive area often tempts the examiner to fill the entire colon. On occasion, this complicates the situation to change the entire problem from one of simplicity to one of considerable hazard. It is true that the valve-like action near the growth may allow comparatively complete evacuation in the normal direction with absolute occlusion to the flow of barium from below. When such is the case, we get the least harm and the greatest aid from this type of examination.

The patient's anemia and electrolyte balance are evaluated and proper therapy is instituted to correct them. We have not been enthusiastic about catharsis in the preparation of the bowel for surgery. Although occasionally

TABLE III
RESECTIONS OF COLON AND RECTUM
Distribution of Cases 1943-1946

| | Cases | Deaths |
|---|-------|--------|
| Carcinoma of colon..... | 100 | 2 |
| Carcinoma of colon (not resectable) | 5 | 2 |
| Carcinoma of rectum..... | 38 | 1 |
| Polyps of colon..... | 9 | 0 |
| Diverticulitis..... | 14 | 2 |
| Other diseases..... | 14 | 0 |
| Total..... | 180 | 7 |

TABLE IV
PORTIONS OF OTHER CONTACT ORGANS RESECTED IN
PRIMARY CARCINOMA OF THE COLON

| 1943-1946 100 Cases | |
|--|----|
| Uterus and adnexa..... | 10 |
| Small intestine..... | 3 |
| Bladder..... | 2 |
| Abdominal wall..... | 2 |
| Stomach, duodenum, spleen, gallbladder, liver, kidney, seminal vesicles—each 1..... | 7 |
| | 24 |

this works well, it more often fails in its accomplishment, and causes the patient a good deal of distress. Perforation and peritonitis may result from vigorous catharsis and enemata. Some individuals do well on small doses of mineral oil, particularly while waiting for admission to the hospital.

Since sulfasuxidine became available, we have been impressed by the value of this drug in its liquefying effect on the fecal contents of the bowel and we used this method of preparation until sulfathalidine was brought out for experimental trial. This latter drug is superior to sulfasuxidine because the remaining bowel contents stay in a semisolid state. This holds bacteria in a mass that is more easily controlled than is possible when the feces are liquid. We believe that sulfathalidine is as effective in the preparation of the

bowel for surgery as is sulfasuxidine. Also, we have not noted the occasional bleeding from the growth when this drug was used that we had observed when sulfasuxidine was in use. The recent finding of Poth, *et al*,⁷ that sulfathalidine and penicillin were antagonistic must be borne in mind. The experimental evidence of Young and Cole⁸ with the use of sulfathalidine and sulfasuxidine intraperitoneally is intriguing, and may be of value if further experience substantiates these views.

During the five to seven days required for suitable bowel preparation, the patient can be put into better condition to withstand surgery. It has not always been possible for us to completely correct the serum protein level by the methods at our disposal. This difficulty has usually been noted in those patients having secondary small bowel involvement. This is particularly true if fistula formation between the attached small intestine and the colon exists but may present a problem when partial obstruction of the small bowel is a

TABLE V
AVERAGE HOSPITALIZATION
Resection of Colon 1943-1946

| | Preop. Days | Postop. Days | Total Days |
|-----------------------------------|----------------|-----------------|---------------|
| One-stage operation..... | 6.5 | 18.3 | 24.8 |
| Two-stage operation: | | | |
| Preliminary cecostomy..... | 3.4 | 29 | 32.4 |
| Prelim. ileotrans. colostomy..... | 5 | 33.3 | 38.3 |
| Prelim. trans. colostomy..... | 7.4 | 47.1 | 54.5 |

part of the picture. It has seemed to us that prolonged attempts to correct the deficiency states are often disappointing. Improvement beyond a certain point is often impossible and a persistence along these lines may lead to a poorer risk rather than a better one. The early favorable changes observed following the removal of an infected, obstructing lesion are spectacular. Such aids as blood, plasma, and amigen appear more effective postoperatively, although the patient's ability to utilize an unobstructed gastro-intestinal tract is probably the chief reason for this impression.

The choice of anesthesia should depend on the circumstances and experience of the surgeon and his anesthesia department. We prefer continuous drip procaine spinal anesthesia supplemented often with small amounts of pentothal sodium.⁹ Since the adaptation of this method, we have observed little evidence of pulmonary complications. It must be admitted that chemotherapeutic agents, used primarily to prevent sepsis in the surgical areas, might well secondarily influence the incidence of pulmonary and bladder infections.

Incisions have varied to some extent depending on previous bowel drainage and the location of the tumor. In primary right colectomy, we have usually found a long right paramedian incision more satisfactory since this allows adequate exposure of the vascular source and nodal spread. Transverse incisions

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are preferred for the flexures and the lesions involving the midcolon. The left colon exposures have been paramedian in cases where permanent colostomy might prove necessary. Oblique incisions with mesial retraction of the rectus muscle have been satisfactory for low sigmoid tumors suitable for end-to-end primary anastomosis. We have practiced delayed primary wound closure, as advocated by Coller and Valk¹⁰ with a minimal of wound infection. Wounds have been closed in layers with No. 30 interrupted cotton and stay-sutures of heavy cotton for the skin and fat. Dehiscence has never been a serious problem, occurring only once in our experience, and this one was in a wound containing an end-colostomy.

Resection of the involved bowel and mesentery has been wide on the cephalward side in all instances. In left colon lesions, the distal segment has been adequate to include any extension of disease into the surrounding tissues. We have found that dividing the bowel between thin clamps in the proximal portion early in the procedure is of great advantage. This makes the remainder of the dissection easier because of better exposure. Instead of isolating named blood vessels to insure viability, we have removed the disease and then determined by visualization that the blood supply of the ends to be anastomosed was adequate. Contact structures are removed with the primary tumor *en bloc*. These have included all the nonvital organs, or parts of them, within the abdomen and pelvis.

Although we championed aseptic anastomosis by a modification of the Parker-Kerr technic in our earlier publications, we have more recently used the open method in all operations of election. Also, we have abandoned the two rows of fine catgut previously advocated. The reasons for our changes in technic have been based on the following factors: The aseptic methods of anastomosis, previously satisfactory in our hands, require considerable experience and a strict attention to detail. Since we were responsible for the teaching, by precept and example, of many resident and graduate students, it became obvious that some of them would have to learn the pitfalls of the method by their own experience. In addition to this, we had great difficulty in carrying out a strictly aseptic technic in some of the low anastomoses. We were further supported by the improvement in bowel preparation brought about by sulfasuxidine and sulfathalidine. By the careful avoidance of gross contamination and the discarding of instruments, drapes, and gloves used in the anastomosis, our results have been as good by this method as they were with the aseptic technic.

We now use an outer row of interrupted sutures of No. 30 cotton. They are placed posteriorly before the clamp is removed from the proximal segment, in all cases, and from the distal segment except when the rectum itself is to be used. We feel that even a thin-bladed clamp damages the nonperitonealized rectum too much to warrant its use in that location. We vary the type of suture used to considerable extent. Transverse mattress sutures are always used across the white lines of the bowel because of the failure of the Lembert suture to hold on these longitudinal fibers. The Halstead mattress suture has

only the advantage of fewer knots, and for this reason may be the choice except when location makes accurate placement difficult to achieve. An inner mucosal approximation is accomplished by very fine chromic catgut on an atraumatic needle. An over-and-over stitch or a locked variety is used posteriorly while the anterior margin is approximated by the Connell method. This technic of an outer row of nonabsorbable interrupted sutures has the advantage of no permanent constriction of the bowel at the point of union. A distended segment can be joined to a collapsed portion by the simple expediency of wider bites on the larger bowel. We have not found much advantage in oblique section of the colon ends, although this is helpful when dealing with the small intestine.¹¹

The rent in the mesentery is carefully closed on both sides when the anastomosis is completely within the peritoneal cavity. If a pelvic dissection has been necessary, we leave the lateral margin between the bowel and pelvic peritoneum open. This obviates the necessity of draining this region, as formerly practiced, through the ischial fossa. Fistula formation with resultant stenosis of the suture line is thereby avoided. Collections of serum in the hollow of the sacrum may burst into the peritoneal cavity with a transient intraperitoneal reaction. As a rule, however, seepage from this space is gradual and is adequately handled by the peritoneal cavity. We have had only one fatality in low anastomoses. This was undertaken in an elderly man, with an extensive growth and liver metastases. On the 18th postoperative day, an enema was given by error. Immediate signs of peritonitis resulted in death five days later from fulminating gas bacillus infection throughout the abdomen. At post-mortem, the suture line was intact but an abscess in the hollow of the sacrum had ruptured, to produce the sequela described above. We doubt that concomitant drainage of the pelvis at the time of the original procedure would have brought about a happier result. This opinion is based on our earlier experience with this region when drainage through the ischial fossa was the rule.

We have given up local use of sulfonamides either into the peritoneal cavity or within the wound. It may be that the use of sulfasuxidine or sulfathalidine, as suggested by Young and Cole,⁸ may prove of benefit when gross contamination by fecal matter has occurred. These investigators find that the above drugs are very rapidly absorbed from the peritoneal cavity, with little evidence of intestinal adhesions in their experimental animals. Sometimes, we have used penicillin intraperitoneally, but are not convinced of its better effect when so administered. If there is no contraindication to sulfonamides, we use sulfadiazine intravenously during and immediately following the operation. Penicillin is substituted for sulfadiazine if the latter may appear to be hazardous. Streptomycin has been used occasionally.

All patients are given enough whole blood to replace that lost during the operation. Further transfusions are given if the blood and protein level of the serum have not been brought within normal range before operation.

Preliminary cecostomy or colostomy are used only in the presence of complete obstruction. Concomitant cecostomy has been abandoned. In

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patients with left colon lesions admitted with acute obstruction, a large tube cecostomy is done as an emergency procedure by a method previously published by us.¹² Recently, Millet,¹³ in our clinic, has devised an ingenious method of cleansing the colon through a previously-placed cecostomy. He inserts a Miller-Abbott tube through a rent in the anterior surface of the rubber arm, leading from the right-angle glass tube used to prevent kinking in the abdominal wall. Complete flushing of the colon is thereby obtained. Salt solution is introduced through one lumen and removed by suction through the other. Suspensions of sulfathalidine can be substituted for saline solution after the cleansing process has become well-established. Inasmuch as the end of the Miller-Abbott tube reaches the point of obstruction by peristalsis, it is very effective even if the colon has inadvertently been filled with barium by an over-enthusiastic Roentgenologist. Millet's method appears, at this time, to be so simple and thorough that preliminary transverse colostomy may be rarely needed in the future. It is of importance however that the preliminary cecostomy be made in a manner suitable for the introduction of the double-lumen tube through it.

Patients are kept mobilized if possible until the day of operation. Some of them can practice early postoperative ambulation. The majority of this group of cases, however, are not candidates for early rising in its true sense of the word. In suitable patients, we used dicoumarol postoperatively to prevent venous thrombosis. Many of them, on the other hand, are arteriosclerotic or have other contraindications to the anticoagulant drugs. In these, we practice prophylactic superficial femoral vein interruption. If the lesion is well above the pelvic floor, this procedure can be done before, or at the time of, the bowel resection. If, however, pelvic dissection is necessary, then the vein interruption should be postponed for 48 hours after operation. There is a transient engorgement of the pelvic veins immediately following femoral vein interruption that definitely increases the blood loss during the pelvic dissection. Since prophylactic vein interruption has been carried out in 458 elderly patients in our hospital without harm, we believe it is a reasonable safeguard against thrombophlebitis and pulmonary embolism.

The average hospital stay in this series of cases was 32.4 days. The average number of days preoperatively was six days. There were 26 cases requiring preliminary bowel drainage or some two-stage procedures. These averaged 39.9 days in the hospital, while those requiring no second stage averaged 24.8 days. The lack of proper home facilities or the distance necessary to travel influenced to some extent the duration of hospital stay.

REFERENCES

- ¹ Allen, A. W.: Right Colectomy for Malignant Disease. *Jour. A. M. A.*, **109**, 923-927, September, 1937.
- ² Allen, A. W., and Welch, C. E.: Malignant Disease of the Colon. *Amer. J. of Surgery*, **46**, 171-180, October, 1939.
- ³ Allen, A. W.: Carcinoma of the Colon. *Surgery*, **14**, 350-366, September, 1943.
- ⁴ Allen, A. W.: Restoration of Continuity *versus* Cure in Carcinoma of the Rectum. *S. G. & O.*, **82**, 490-491, April, 1946.

- ⁵ Gilchrist, R. K., and David, V. C.: Lymphatic Spread of Carcinoma of the Rectum. *ANNALS OF SURGERY*, **108**, 621-642, 1938.
- ⁶ Collier, F. A., Kay, E. B., and MacIntyre, R. S.: Regional Lymphatic Metastasis of Carcinoma of the Rectum. *Surgery*, **8**, 294-311, 1940.
- ⁷ Poth, E. J., Wise, R. I., and Slattery, M. P.: Penicillin-Phthalylsulfathiazole Antagonism. *Surgery*, **20**, 147-149, July, 1946.
- ⁸ Young, John P., and Cole, Warren, H.: Intraperitoneal Administration of Succinylsulfathiazole and Phthalylsulfathiazole. *Arch. Surg.*, **53**, 182-189, August, 1946.
- ⁹ Arrowood, J. G., and Foldes, F. F.: Subarachnoid Analgesia Maintained by the Continuous Drop Method. *Archives Surg.*, **49**, 241-244, October, 1944.
- ¹⁰ Collier, F. A., and Valk, W. L.: Delayed Closure of Contaminated Wounds: Preliminary Report. *ANNALS OF SURGERY*, **112**, 256-270, 1940.
- ¹¹ Dennis, Clarence: Oblique, Aseptic, End-to-end Ileac Anastomosis: Procedure of Choice in Strangulating Small Bowel Obstruction. *S. G. & O.*, **77**, 225-242, September, 1943.
- ¹² Allen, A. W., and Welch, C. E.: Cecostomy. *S. G. & O.*, **73**, No. 4, 549-552, October, 1941.
- ¹³ Millet, J. B.: Personal communications.
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DISCUSSION.—DR. WARREN H. COLE, Chicago, Ill.: These figures of Doctor Allen's revealing no deaths following resection in 87 cases of curable carcinoma of the colon are excellent, but I am afraid that anyone who has had such a large series without a death will have one, even though it is due to something as unexpected as plaster falling from the ceiling upon a patient. I am glad he has emphasized the advisability of a two-stage resection in a large percentage of patients with carcinoma on the left side (where obstruction is so common), because the tendency to switch toward a one-stage resection is bound to go too far, and we will lose patients who should have had a two-stage operation. I make this statement largely because I work in a charity hospital where the great majority of our patients with carcinoma of the left colon have at least a partial obstruction; many have complete obstruction. It is not safe to consider a one-stage procedure in that group.

I was glad to hear Doctor Allen say he was doing most of his cases with open technic. I am firmly convinced that this is safe, particularly with the use of sulfasuxidine or sulfathaladine by mouth preceding operation. I do not know what he thinks about these drugs, but I personally feel they have great merit and will help us obtain a smoother convalescence, and a lower mortality rate.

DR. ARTHUR W. ALLEN, Boston, Mass.: I would like Doctor Cole to answer one question. He has advocated intraperitoneal use of sulfasuxidine and sulfathaladine, and I should like to know how he feels about it at this time.

DR. WARREN H. COLE, Chicago, Ill.: I did not mention intraperitoneal use of sulfasuxidine and sulfathaladine because streptomycin may have made that procedure obsolete. We used one of these drugs (6 Gm. intraperitoneally) in every case of colon resection until streptomycin became available. I was convinced that it helped in lowering complications. When placed in the peritoneal cavity either of these drugs is absorbed rapidly but it is not absorbed from the wound; their use must be limited to the peritoneal cavity. Absorption is not quite so rapid as with sulfanilamide, but much more rapid than with sulfathiazole or sulfadiazine; these drugs produce no adhesive reaction, as is occasionally noted with the latter two drugs. Since sulfasuxidine and sulfathaladine are so effective in limiting the growth of *B. coli* in the lumen of the large bowel, it appears logical to expect a similar action in the peritoneal cavity when large bowel contamination has taken place.

THE PERSISTENCE OF SYMPTOMS FOLLOWING CHOLECYSTECTOMY*

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THE RECOGNITION of a definite syndrome associated with disease of the biliary tract, particularly calculi, extends back hundreds of years. Aggressive treatment of this syndrome, however, is hardly 75 years old. Surgical attention was first directed at the removal of stones from the gallbladder, with the operation of cholecystostomy. This was followed shortly afterward by extirpation of the gallbladder, and in a relatively short period of time both of these procedures were being performed with sufficient safety to warrant their inclusion in the armamentarium of the surgeons.

As cholecystostomy and cholecystectomy became more frequently performed, it was possible to evaluate the efficacy of each, and this was done by frequent reports of large series of cases studied statistically. This was an expensive method, yet proved to be an effective one. Fairly early, it became obvious that the results obtained in simple drainage of the gallbladder in patients with chronic cholecystitis were not nearly so satisfactory as those that followed cholecystectomy. This latter operation, therefore, has, during the years, become the procedure of choice, and one seldom encounters anyone advocating cholecystostomy except in the occasional case of acute involvement of the gallbladder where the surgeon thinks that cholecystectomy at that time would be too formidable a procedure for the patient. It also became possible to prognosticate, with a considerable degree of surety, the particular patient who would be relieved of his distress following cholecystectomy. While there have been many contributions on this phase of the subject, the papers of Judd,¹ Whipple,² Mueller,³ Finsterer,⁴ Elman,⁵ and Parsons,⁶ are adequate. Where stones are present in the gallbladder and where the patient gives a history of typical biliary colic on several occasions, and where there is a history of nausea, vomiting and dyspepsia, one can usually anticipate a successful outcome. If to this history is added the physical finding of tenderness in the region of the gallbladder and the radiologic finding of nonvisualization of the gallbladder with cholecystography, or the presence of stones, the surgeon can usually anticipate that from 80 to 95 per cent of his patients will be relieved of their symptoms following cholecystectomy.

In the stoneless gallbladder, the results have not been so satisfactory. With the advent of cholecystography and the ability to detect slight functional damage in the gallbladder, it was hoped that early cholecystectomy, in such

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individuals, would offer a definite therapeutic advance. This has not proved to be the case. In a study by Graham and Mackey,⁷ it was shown that where typical biliary colic was not an important feature in a patient with a stoneless gallbladder, cholecystectomy was doomed to failure in as high as 40 per cent of the instances. In that study, they made the interesting observation, which has been noted by others, that the relief of the symptoms of cholecystitis in the stoneless gallbladder was in almost direct proportion to the amount of damage present in the gallbladder wall. The greatest relief of symptoms was obtained in those patients in whom the gallbladder wall was thickened by virtue of fibrous tissue, edema and cellular infiltration, whereas those patients with relatively thin, normal looking gallbladder walls were for the most part destined not to be relieved of their symptoms unless stones were present. The failure of the concentrating ability of the gallbladder to function as determined by cholecystographic study, therefore, was not in itself an indication for cholecystectomy, and, thus, by inference the loss of function of the gallbladder was probably not the origin of the symptoms seen in the classical form of cholecystitis.

While cholecystectomy in the properly selected patient is one of the most satisfactory of abdominal operations, it is performed frequently enough for the relatively small percentage of unimproved patients to be a serious clinical problem. As a result there have been many reported studies as to why these symptoms persist and many suggestions have been offered as to their proper care. While no attempt will be made to review all of these reports, it is well that previous approaches be considered.

In our discussion we shall exclude those patients in whom other lesions, obviously responsible for the postoperative disability, can be demonstrated. Prominent among such causes are found peptic ulcers, duodenal diverticula with ampullary obstruction, diaphragmatic hernia, spinal nerve lesions, and the like. A certain number of patients will also show the persistence of stones in the common bile duct or in the stump of the cystic duct. Here the cause of the symptoms is obvious. Others will show traumatic damage to the common bile duct, and here, again, the solution to the problem is usually clear. After such patients have been excluded, there will still remain a considerable group in which careful review of the preoperative history and findings fail to add further information. As Elman⁸ has pointed out, if some of these patients are studied during the period of intense colic for the concentration of amylase in their blood, this will often be found elevated. A high amylase value which falls rapidly to normal with subsidence of the acute attack is generally diagnostic of an acute episode of interstitial pancreatitis. It is important, therefore, that such determinations be made preoperatively, if possible, during the attack of so-called biliary colic. While this lesion is frequently associated with cholecystitis, it is well for the surgeon to be warned beforehand of the associated pancreatic involvement.

Residual biliary tract infection has been suggested as one of the common causes for the persistence of symptoms. This explanation would seem to be

of doubtful value. As has been pointed out, patients with noncalculus cholecystitis and cholangitis is often relatively free from severe pain, and one may frequently encounter various types of infectious hepatitis in which there is no pain at all, and, indeed, very little dyspepsia.

Distortion, due to adherence of the duodenum or the pyloric region of the stomach to the gallbladder bed region, has, likewise, been suggested as an origin of the difficulties. Release of such adhesion, however, rarely relieves the individual. In operations upon the common bile duct that has become strictured as a result of previous traumatic injury, one is frequently surprised to note the extensive fixation of the duodenum to the liver and even to the anterior abdominal wall, with relatively few dyspeptic symptoms.

One of the most common explanations referred to regarding the persistence of symptoms following cholecystectomy is that of biliary dyskinesia. The subject has been adequately reviewed by Ivy and Sandbloom.⁸ This concept has to do chiefly with the mechanism of the choledochoduodenal sphincter and its neuromuscular relationship to the remainder of the biliary apparatus and the duodenum. While a functional spasm of this sphincter had been previously suggested by others, the experimental work of Westphal⁹ gave great impetus to further observations. Westphal, working on guinea-pigs, brought out the fact that moderate stimulation of the vagus nerve below the diaphragm with a weak electrical current would produce contraction of the gallbladder, peristaltic motion in the antral portion of the sphincter of Oddi, and relaxation of the papilla. He looked upon this as the normal response. If the current was made slightly stronger, gallbladder contraction became greater, and peristaltic movements into the ampulla were also greatly increased. When a still stronger current was used, he noted that with the strong contraction of the gallbladder there was a spasm of the antral sphincter. He also noted that upon stimulation of the splanchnic nerve, the gallbladder and the antral portion of the sphincter relaxed while the sphincter of the papilla contracted. This he called atonic dyskinesia in contradistinction to the previously mentioned type, which was hyperkinetic dyskinesia. This led him to a rather elaborate classification of the operations of this physiologic mechanism, much of which has not been confirmed in the human. It was felt by Ivy and Sandbloom in their report that this choledochoduodenal mechanism could contract with sufficient force to prevent the evacuation of the contracted gallbladder and that by so doing, the resulting back pressure would be adequate to produce pain even in the non-inflamed biliary passage. Just how important a factor such as dyskinesia may be in clinical cholecystitis need not concern us here. Following removal of the gallbladder there is some question as to whether the rôle played by the sphincter of Oddi and the mechanism of reciprocal innervation is a dominant one. Weir and Snell¹⁰ have suggested that it might be important. They have pointed out that there may be instances in which some abnormality of the sympathetic or parasympathetic innervation may produce spasm or increase in tone of the sphincter of Oddi which could produce sufficient back pressure and distention of the common bile duct to cause pain. That colicky pain associated

with nausea and vomiting can be produced from sudden distention of the common bile duct has been demonstrated in the human by Zollinger,¹¹ who placed a small balloon in the common bile duct at operation and rapidly inflated it. The demonstration of a true sphincteric spasm in the human, however, is not too clear-cut. Puestow¹² has offered evidence that exactly the opposite occurs following cholecystectomy. By transplanting fragments of the duodenum containing the intramural portion of the choledochus and the ampulla of Vater to the surface of the abdomen of animals, he made direct observations of bile flow, and came to the conclusion that cholecystectomy produced a loss of sphincter tonus and a more or less constant flow of bile. He explained the evidence offered by others of increased pressure within the common bile duct following cholecystectomy as being due to determinations made too soon after operation, while edema was still present in the ampullary region. In most of the clinical and experimental observations that have been made, it is difficult to exclude the effect of the duodenal musculature. It is our observation, on unreported experiments, that when the vagus nerve of a dog is stimulated in the neck with a strong electric current, not only is there contraction of the gallbladder and the duct musculature but of the duodenal wall as well. This latter muscle is so much more powerful than the sphincteric mechanism of Oddi that it might very easily offset the effect of any contrary innervations that might be present.

Another explanation for postcholecystectomy colic and dyspepsia that has been offered relates to the dilatation of the choledochus that is seen so frequently following cholecystectomy. This is an old observation, and yet the explanation is not too clear-cut as to why it should occur. Some of the evidence offered is still controversial. Puestow was unable to note any considerable enlargement of the choledochus when it was associated with untreated cholecystic disease. Benson,¹³ on the other hand, in necropsy studies, found that in mild gallbladder disease without cholecystectomy there was a 32 per cent increase in diameter, while in severe gallbladder disease this increase was on an average of 64 per cent. Practically all observers agree, however, that in the majority of instances following cholecystectomy for gallbladder disease there is a considerable increase in diameter of the choledochus. The most common explanation offered for this observation is related to a loss of the water-absorbing mechanism that exists in the gallbladder, resulting in considerable back pressure. Another explanation that has been advanced is that it is the result of duodenal regurgitation. Puestow concludes that following cholecystectomy there is a permanent dilatation of the choledochus, but that there is no satisfactory explanation at the present time for this dilatation. He feels that it is usually associated with a low intraductal pressure and, therefore, tension within the choledochus is probably not responsible for postoperative symptoms. The observations of Benson, again, are of interest in this respect. He studied a number of patients coming to necropsy several years after cholecystectomy in order to determine the relationship between dilatation of the duct to the postcholecystectomy distress.

Where such distress was found, only 14 per cent showed normal-appearing ducts, while 86 per cent were markedly dilated. Of those patients who had no postoperative abdominal symptoms, 83 per cent of the bile ducts were normal in diameter, while only 17 per cent were markedly dilated. He feels, therefore, that distress after cholecystectomy is closely related to dilatation of the bile duct, and that this latter phenomenon is due to the loss of the absorptive function of the gallbladder and to the subsequent rise in pressure within the duct system. These observations correlate with the experiments of Schrager and Ivy,¹⁴ and Davis, Hart and Crain,¹⁵ who found that distention of the cystic duct and bile ducts in dogs was associated with pain, nausea (salivation), and vomiting. Butsch, McGowan, and Walters¹⁶ have demonstrated that when a T-tube is inserted into the common bile duct after cholecystectomy and manometric determinations made of the intraductal pressure, this pressure can be made to rise with the administration of certain drugs, such as morphine. In one of the cases studied, this rise in pressure was accompanied by pain. They also noted periodic rises in pressure, with pain at times independent of the effect of morphine. Conversely, they were able to demonstrate that relaxation produced by amyl nitrite and glyceryl trinitrite relieved the pain concomitantly with the fall in intraductal pressure. A similar observation has been made independently by Doubilet and Colp.¹⁷ It is also a common clinical observation, not supported by observations of intraductal pressure, that the pain in postcholecystectomy colic can frequently be relieved by the administration of glyceryl trinitrite.

One final observation must be considered as relating definitely to the association of symptoms following removal of gallbladder, namely, the persistence of a large portion of the cystic duct. This occasionally increases in size, so that it mimics a reformed gallbladder. Frequently the wall is thickened and a small stone is present. Often, however, this remnant of the cystic duct will not contain stones, and occasionally the wall has the thickness generally associated with a normal viscus. The removal of such a cystic duct stump has frequently resulted in the relief of symptoms, as has been pointed out by Beye,¹⁸ and Gray and Sharp.¹⁹ Strangely enough, there has been but little comment on the mechanism by which the remnant of a cystic duct can produce symptoms identical to those of biliary colic, and why these symptoms will be relieved following the removal of the duct. The presence or absence of stones seems to make but little difference in the end-result.

From the above considerations, it would seem that some common denominator must be sought for, in which an explanation of the relief of symptoms from the removal of the stump of the cystic duct, or the relief of tension in the common bile duct, or the probable relief of spasm of a choledochal sphincter might correlate. Since the symptoms under discussion in the so-called postcholecystectomy syndrome resemble identically those of cholecystitis and cholelithiasis, it would seem to us that such explanations as are offered must also correlate with the cause of symptoms seen in the usual case of cholecystitis.

Recently,²⁰ we had occasion to report on certain observations relating to the production of symptoms of cholecystitis. Because of the fact that the symptoms commonly observed in cholecystitis, such as pain, nausea, vomiting, and dyspepsia, are symptoms that can best be explained on the basis of sympathetic and parasympathetic stimulation in the gallbladder region, we examined

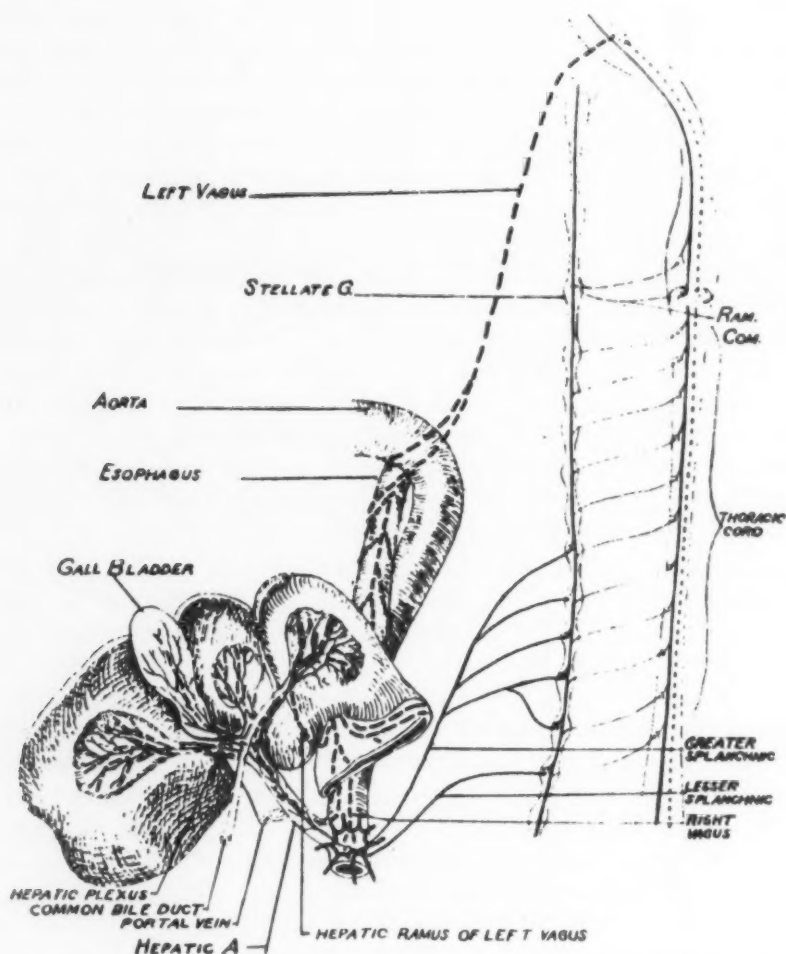


FIG. 1.—Diagrammatic representation of the origin and gross distribution of the sympathetic and vagus nerve supply to the biliary tract and liver. (After Kuntz²⁴)

the walls of diseased gallbladders to ascertain, if possible, whether any lesion could be demonstrated involving these nerve pathways. We were able to show that in chronic cholecystitis, in which there is generally seen marked inflammatory changes in the wall of the gallbladder and in which the patient exhibits a considerable amount of pain, nausea and vomiting, it is very easy to

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demonstrate pathologic changes in and around the nerve fibers within the gallbladder wall. These changes, for the most part, consist of fibrosis and inflammation producing stretching, ischemia, and the local effect of inflammation around the nerve fibers and endings. These factors either actually produce pain or else so lower the threshold so that stimuli not normally apparent to the individual may result in marked symptoms. Following cholecystectomy

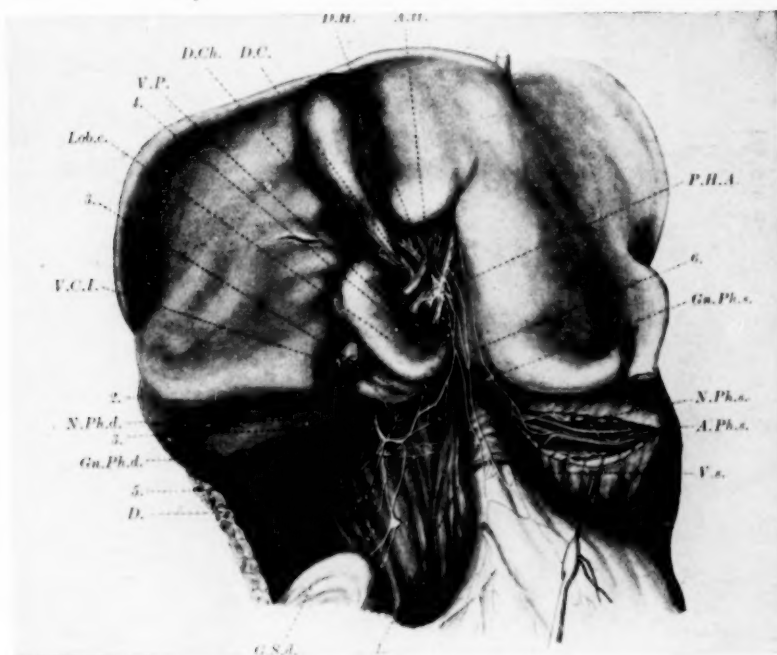


FIG. 2.—(A) Drawing prepared from dissection of an adult with the hepatoduodenal ligament removed and the liver raised to illustrate the distribution of the phrenic supply to the liver. V.C.I.—inferior vena cava, cut through; Lob.c.—caudate lobe; D—diaphragm; G.S.d.—right adrenal gland; A.H.—hepatic artery; D.H.—hepatic duct; V.P.—portal vein; A.Ph.s.—left inferior phrenic artery; D.C.—cystic duct; N.Ph.d.—right phrenic nerve; Gn.Ph.d.—right phrenic ganglion; V.s.—left vagus; N.Ph.s.—left phrenic nerve; Gn.Ph.s.—left phrenic ganglion; 1.—hepatic rami of the vagus nerve; 2.—phrenic branches to the inferior vena cava; 3.—branches to the posterior surface of the liver; 4.—the branches in the portal area; 5.—muscular branches; 6.—the branches of the left phrenic nerve to the portal area. (After Raigorodsky²²)

many nerve fibers, as well as the above mentioned lesions, are removed, and with this loss of a large number of nerve trunks along with the focus of stimulation, there is subsequent improvement in the clinical condition of the patient. These observations were demonstrated with characteristic photomicrographs observed on routine examination.

If these above mentioned observations are true, it would seem to us that a similar mechanism must be shown to be present in explanation of the existence of the same symptoms following cholecystectomy. This report concerns such a study of the nerve supply relating to the bile ducts. In view of

the fact that so little attention has been paid to the nerve supply to this region, we feel that it would be of value to describe first the anatomic distribution in detail.

THE NERVE SUPPLY TO THE BILE DUCTS

The nerve supply of the liver and biliary system is derived from the sympathetic, the vagus, and the phrenic nerves. Dogiel²¹ pointed out, in 1895, that the gallbladder and bile ducts, including the cystic and common ducts,

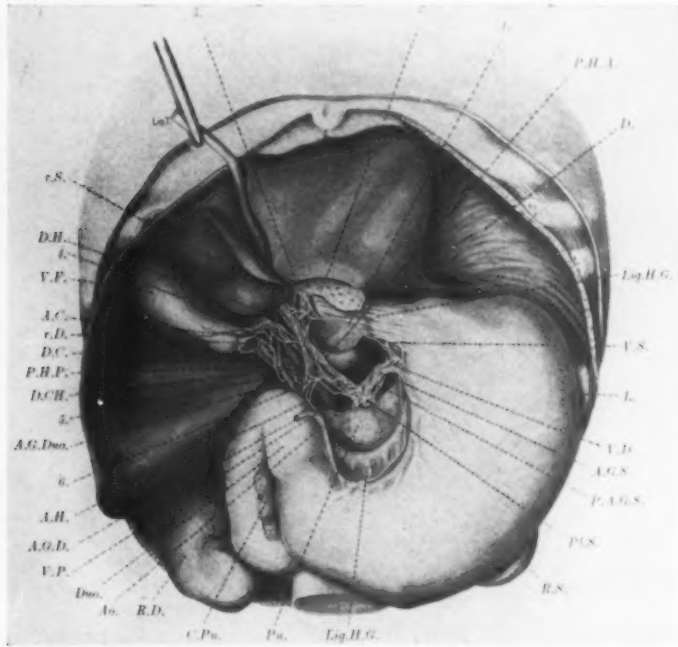


FIG. 2.—(B) Preparation as dissected from a child showing the more common type of arterial and nerve distribution. D—diaphragm; Lig.H.G.—Lig. hepatogastricum; L—spleen; R.S.—right kidney; Pn.—pancreas; C.Pn.—head of the pancreas; R.D.—right kidney; Duo—duodenum; Lig.t.—ligamentum teres; V.F.—gallbladder; Ao.—aorta; A.H.—hepatic artery; A.G.Duo.—gastroduodenal artery; A.G.S.—left gastric artery; A.G.D.—right gastric artery; r.S.—left hepatic artery; r.D.—right hepatic artery; A.C.—cystic artery; P.L.S.—solar plexus; P.A.G.S.—plexus of the left gastric artery; P.H.A.—anterior hepatic plexus; P.H.P.—posterior hepatic plexus; V.S.—left vagus; V.D.—right vagus; 1.—hepatic branch of the left vagus; 2.—branches to the liver; 3.—branches to the anterior hepatic plexus; 4.—medial nerve of the gallbladder; 5.—posterior nerve of the common bile duct; 6.—plexus of the gastroduodenal artery. (After Raigorodsky²²)

have a relatively rich nerve supply. A detailed study by Raigorodsky,²² in 1928, in which he carefully dissected 60 human specimens, led to much clarification of the subject.

Figure 1 is a diagrammatic representation showing the pathways of the sympathetic and vagus nerve supplies to the liver and bile ducts. The left

vagus gives rise to three main branches as it passes through the lower thorax on the anterior surface of the esophagus. The right division is the hepatic branch, the middle and left being distributed to the stomach. The hepatic branch passes to the liver through the gastrohepatic ligament where it is joined by a branch of the right vagus. The distribution is almost entirely to the left lobe of the liver. As the right vagus passes along the posterior surface of the esophagus, most of the fibers pass to the celiac ganglia, where a few

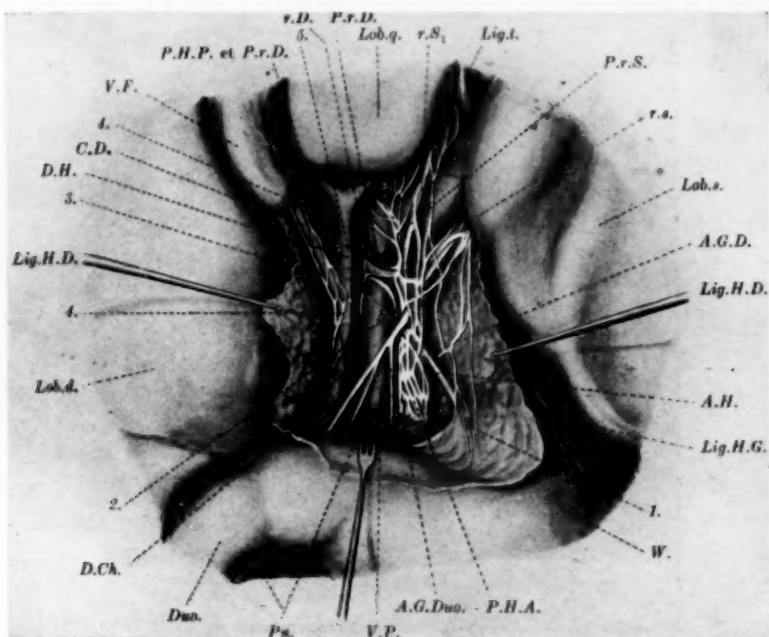


FIG. 2.—(C) Preparation of an adult with normal topographic relations seen from in front. Lob.s.—left lobe of liver; Lob.d.—right lobe of liver; Lob.q.—quadrate lobe of liver; Lig.t.—lig. teres; W—stomach; Duo.—duodenum; Pn.—pancreas; Lig.H.G.—hepatogastric ligament; Lig.H.D.—hepatoduodenal ligament; A.H.—common hepatic artery; A.G.D.—right gastric artery; A.G.Duo.—gastroduodenal artery; r.D.—right branch of the hepatic artery; r.s. and r.SI—left branch of the hepatic artery; V.P.—portal vein; P.H.A.—anterior hepatic plexus; P.H.P.—posterior hepatic plexus; 1.—nerves with the right gastric artery; 2.—anastomosis between the anterior and posterior hepatic plexus; 3.—lateral nerve of the gallbladder; 4.—cystic duct; 5.—medial cystic nerve. (After Raigorodsky²²)

small branches become incorporated in the hepatic rami and enter the hepatic portal. Eiger²³ (1916) considered the vagus to have the influence of a true secretory nerve on the liver.

The majority of the nerve fibers which are distributed to the biliary tree are derived from the sympathetic system, and reach the liver by way of the celiac plexus (Kuntz).²⁴ These fibers are derived from the greater splanchnic nerves which have their origin predominantly from the T6-T9 sympathetic

ganglia, and the lesser splanchnics which arise from the T10-T12 sympathetic gangli. According to de Takats,²⁵ the greater splanchnic enters the superior portion of the celiac plexus, whereas a part of the lesser splanchnic joins the inferior pole, the majority being distributed to the renal and suprarenal plexuses. As has been pointed out by Greving²⁶ (1924), none of the



FIG. 2.—(D) Photograph of a dissection of the nerves of the portal area, as prepared by Raigorodsky.²² The portal vein has been removed, and black silk has been placed behind the nerves for contrast. V.—stomach; Pn.—pancreas; Duo.—duodenum; A.G.S.—left gastric artery; v.P.—portal vein (cut end); v.C.I.—inferior vena cava; D.Ch.—common bile duct; D.H.—hepatic duct; Pl.S.—solar plexus; P.H.A.—anterior hepatic plexus; P.H.P.—posterior hepatic plexus; P.A.G.S.—plexus of left gastric artery; V.S.—left vagus; V.D.—right vagus; 1.—hepatic ramus of left vagus; 2.—branch from the right vagus; 3.—branch from the plexus of the left gastric artery; 4.—medial cystic nerve; 5.—inner branch of the posterior nerve of the common duct; 6.—posterior nerve of the common duct; 7.—branch from the left vagus; 8.—anastomosis between the anterior and posterior hepatic plexus; 9.—pancreaticocholedochus nerve. (After Raigorodsky²²)

sympathetic rami join the liver directly from the sympathetic trunks in man, but first pass through the hepatic plexus.

Figure 2-A is a drawing prepared by Raigorodsky showing the rami from the phrenic nerves to the liver. These fibers enter by first anastomosing with

the sympathetic nerves. This occurs predominantly along the posterior border, although some fibers enter through the hepatic portal.

The studies of Raigorodsky led him to divide the hepatic plexus, which is formed by the fibers approaching the liver from the celiac plexus, into anterior and posterior portions. The anterior hepatic plexus always follows the hepatic artery, the pathway changing as the path of the artery varies. The basic types of vessel differences correspond to the special pathways of nerves. Four basic types were originally described by Rio Branco.²⁷

The most prevalent type occurs in 55 per cent of all cases (Fig. 2-B and 2-C). The hepatic artery arises from the celiac axis and divides into two branches, the artery hepatic propria and the gastroduodenal artery. The hepatic propria artery divides into the right and left hepatic arteries, the right giving rise to the cystic artery just before it enters the liver.

The second type constitutes 20 per cent of the cases studied. The basic origin of the common hepatic artery is the same, but the right and left hepatic arteries arise directly from the common hepatic as separate branches without the formation of the hepatic propria artery. The cystic artery again arises from the right hepatic artery.

The third type is present in 10 per cent of the cases. The right hepatic distribution remains the same while the left hepatic artery arises as a separate branch from the left gastric artery.

The fourth type is found in 10 per cent of the cases also. The right hepatic artery arises as a separate branch from the superior mesenteric artery, passes behind the portal vein, and gives off the cystic artery just before entering the liver. The left gastric has the same type of basic pattern described in type one.

The other 5 per cent consists of variations and combinations of the above four basic types.

The posterior hepatic plexus of nerves passes to the right and superiorly in the portal area where at first it lies behind the lower third of the portal vein and crosses over on the under surface; it is then found lying in the outer groove between the right periphery of the portal vein and the common bile duct where it passes to the liver which it enters in the region of the end-branches of the right hepatic artery. Along the course of the right hepatic artery, it anastomoses with ramification of the anterior hepatic plexus.

The medial nerve of the gallbladder arises from the anterior plexus, passes over the anterior surface of the common and hepatic ducts, anastomoses with the posterior hepatic plexus in the triangle of the cystic and hepatic ducts, and passes to the medial superior surface of the gallbladder.

The lateral nerve of the gallbladder arises from the posterior plexus and passes along the lateral surface of the common and cystic bile ducts to the lateral, inferior surface of the gallbladder.

The pancreaticocholedochus nerve, as described by Laterget,²⁸ is derived from the posterior hepatic plexus and passes distally to the retro- and intra-duodenal portions of the common bile duct.

The common duct is surrounded by a delicate net of nerve fibers throughout most of its extent. These fibers are much more numerous in the region of the junction of the hepatic and cystic ducts. The posterior surfaces of the cystic, hepatic, and common ducts are in close proximity to the posterior hepatic plexus which contains many large nerve fibers. Across the anterior surfaces of the hepatic, cystic, and common ducts pass many of the connecting branches between the anterior and posterior hepatic plexuses and the rami of origin of the medial nerve of the gallbladder.

Along the lateral inferior surface of the cystic duct is the lateral nerve of the gallbladder, while on the medial superior surface is the medial nerve of the gallbladder. As can be seen, one of the points of maximal concentration of nerve fibers along the biliary ducts is in the triangle formed by the cystic and hepatic ducts.

Labat²⁰ indicates that the gallbladder is insensitive, but that the bile ducts are very sensitive to tension of distention. However, Dogiel pointed out that nerve fiber bundles arising from the hepatic plexus accompany the blood vessels into the wall of the gallbladder and bile duct and form a plexus in the outer connective tissue layer from which fibers are distributed to the musculature and the mucosa. This plexus was described to contain many ganglion cells which occur singly or in groups. Greving (1924) was unable to confirm the presence of the ganglion cells in his preparations. We, however, have identified them on numerous occasions.

The sympathetic fibers probably make synaptic connection in the celiac ganglia. The connections of the vagus are not so well known, but the hepatic plexus may be the site of synapse, and if Dogiel is correct in his assumptions, the ganglion cells which he demonstrated were probably parasympathetic. As has been pointed out, some of the vagus fibers enter the liver directly. According to Kuntz, no anatomic data are available which prove that the efferent fibers in these branches effect synaptic connections with peripheral neurons. It is possible that some of these fibers are the axons of neurons located in the jugular or nodose ganglia.

The clinical observations of Kocher on cord injuries have shown, as early as 1896, that the vagi have no pain-carrying fibers from the abdomen (de Takats). As we have stated, it has been demonstrated experimentally by others that distention of the biliary ducts caused marked distress, disturbance in respiratory rhythm, salivation, and often vomiting. The symptoms produced were generally more marked with distention of the ducts than the gallbladder. Section of the right splanchnic nerve was found often to abolish the distress and reduce the amount of the respiratory inhibition. Section of both vagi and the left splanchnic nerve stopped the salivation and vomiting and reduced the amount of respiratory inhibition, while section of both vagi and both splanchnic nerves abolished all distress and reflex disturbances.

Reference has previously been made to the studies on a series of conscious patients made by Zollinger on the effects of distention of the gallbladder and bile ducts. Distention of the gallbladder was found to cause moderate

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discomfort, no vomiting, and no referred pain. Distention of the cystic or common bile duct caused severe epigastric distress, vomiting in two of three cases, and no referred pain. He considered this evidence in agreement with Morley³⁰ that a true visceral pain does exist which is mediated through the sympathetics, and that inflammation of the peritoneum causes referred pain over a peritoneocutaneous reflex. Kulenkampff, as reported by de Takats, emphasizes the fact that muscular rigidity will disappear with splanchnic anesthesia in colic if it is of reflex origin. However, if rigidity is due to peritoneal involvement resulting from the contiguous extension of the inflammation or to adhesions, the rigidity will not be influenced.

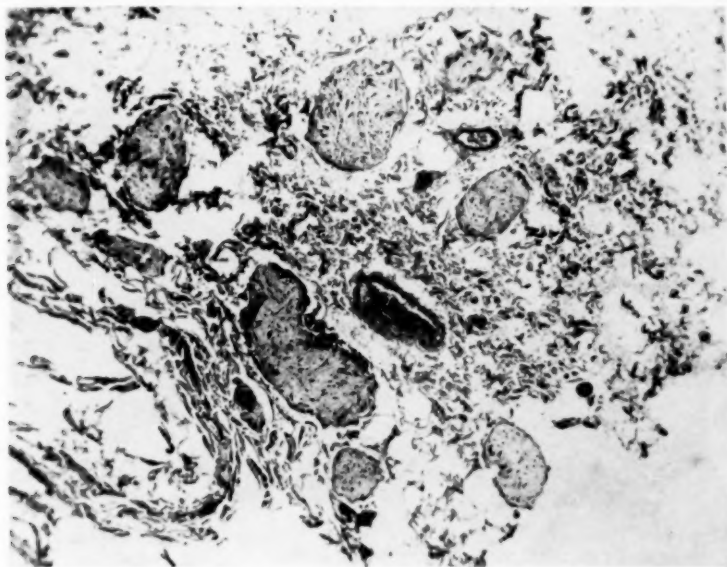


FIG. 3.—Photograph of nerve fibers in section of the cystic duct taken just proximal to the point where the duct was clamped at operation. Other nerve fibers were present in each cross-section. These groups of fibers in each case possibly represent the medial or lateral nerves of the gallbladder after branching has taken place.

From the above observations, it seems logical to assume that stimulation of the sympathetic nerves in the portal area would cause epigastric pain and some disturbance in the respiratory rhythm, while stimulation of the vagus fibers in the same area would cause dyspepsia and in some cases vomiting.

In an effort to determine whether an appreciable amount of nerve fibers were cut during the average cholecystectomy, a consecutive series of gallbladders sent to the surgical pathology laboratory from Barnes Hospital were sectioned transversely through the cystic duct just proximal to the point where the clamp had been placed. Figure 3 shows nerve fibers which were found in this area. The nerve trunks can be seen to be quite small and numerous as

branching of the larger trunks has occurred. Many other fibers on the other surfaces of the cystic duct are not shown.

Figure 4 is a gross dissection of a fresh anatomic specimen. The duodenum and pancreas have been rotated 90 degrees for clarity. The trunks from the celiac plexus can be seen passing to the hepatic plexus, probably the posterior portion which is in close proximity to the cystic duct and cystic artery. The medial branches are probably connecting branches passing to the anterior hepatic plexus along the hepatic artery. The lateral nerve of the gallbladder can be seen very clearly as it has been dissected free throughout



FIG. 4.—Dissection of adult specimen. The duodenum and attached pancreas have been rotated 90° to the left for clarity. A hook has been placed beneath three large nerve trunks which are passing superiorly from the region of the celiac plexus along the posterior and lateral surfaces of the common duct. The lateral nerve of the gallbladder can be seen distinctly with a hook near its termination. The posterior hepatic plexus can be seen just inferior to the cystic duct which has been retracted superiorly by the left black suture. The right black suture is around the cystic artery, and the right hook is attached to the medial wall of the hepatic duct.

its course along the cystic duct. It must be remembered that in the dissections and most of the illustrations, in the interest of clarity the structures in the portal area have been spread, whereas in reality they lie in relatively close proximity.

CASE REPORTS

Case 1.—J. W., a white female, age 66, was first admitted to the Barnes Hospital, March 9, 1945, with a history that 11 years previously a cholecystectomy had been performed following episodes of right upper quadrant pain, with nausea and vomiting,

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but with no chills or fever. Roentgenograms at that time showed stones in the gallbladder. At operation, one large and several small stones were found. She was asymptomatic for two years after operation. She then began to note a beginning return of some of the same symptoms for which she was operated upon the first time. These attacks at first lasted for about five minutes, and occurred every three or four months. There was no jaundice or alcoholic stools or dark urine. The attacks increased gradually in frequency and intensity during the intervening years. Pain in the right upper quadrant radiated down the subcostal ridge but not to the scapula or shoulder. There were no chills or fever but occasional nausea and vomiting. There was no jaundice. During the past few months she had had nearly daily attacks for which hypodermics had been ordered. The attacks were characterized by a cramping, colicky, right upper quadrant pain associated with

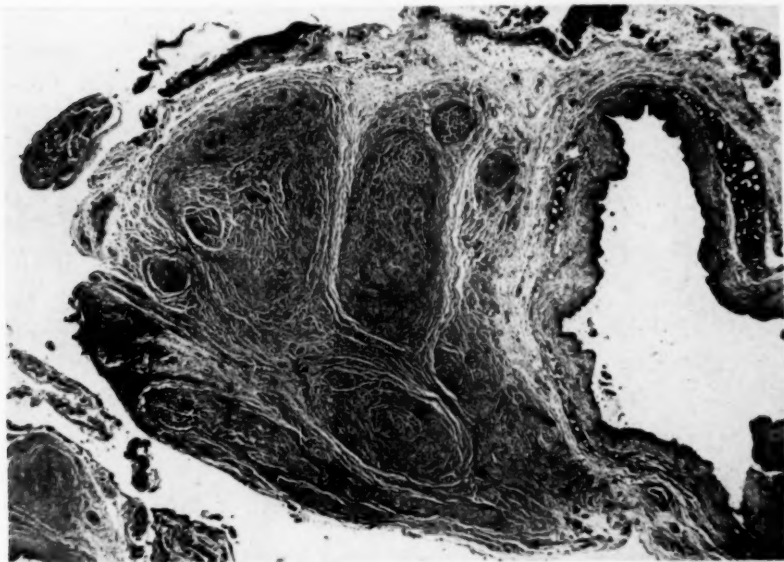


FIG. 5.—Case 1: Fibrous tissue overgrowth in regenerating nerves around the remnant of the cystic duct producing the picture of an amputation neuroma.

nausea and vomiting. More recently there was moderate jaundice, dark urine, and light stools, with some itching. In intervals between the attacks which were sudden in onset, the patient was asymptomatic.

Physical examination upon admission to the hospital was essentially within normal limits. The laboratory findings showed the urine, red and white blood cell studies, and hemoglobin to be normal. The nonprotein nitrogen was 19 mg. per cent; fasting blood sugar 80 mg. per cent, total plasma protein 6.3, with albumin of 3.7, and globulin of 2.6. Blood amylase was 143 units, and the icterus index was 7.5. The gastro-intestinal roentgenologic examination was normal, and the electrocardiogram was normal.

On March 15, 1945, the upper right rectus scar was excised by Doctor Womack, and very little musculature encountered. The omentum and duodenum were intimately adherent to the abdominal wall. They were dissected free with great care. The pelvic viscera were normal, as was the large bowel, with the exception of the appendix which was acutely kinked and dilated distally. This was removed and the stump inverted. The duodenum was now separated from the liver by sharp dissection and mobilized with the head of the pancreas, away from the posterior wall. The gastroduodenal artery, the

portal vein, the common bile duct, and the vena cava were identified. The common bile duct was enlarged two times, the wall was thin and colored a slate-blue. It contained no stones. It was separated from all fibrous tissue from the upper margin of the pancreas to the liver. The cystic duct had its origin from the mesial surface of the common duct, extending around posteriorly for a distance of 1.5 cm. It was enlarged to the size of one's little finger and had a bulbous tip. There were no stones present either in the cystic duct or common duct. The common duct emptied well, and was not explored. There were numerous large nerve trunks running into the stump of the cystic duct and the impression was that the patient's symptoms could be explained on the basis of an amputation neuroma. The cystic duct was cut-off close to the common duct and ligated with a silk suture. A drain was inserted to this area and brought out through a stab wound. The peritoneum was closed with No. 00 chromic catgut and the fascia brought together with interrupted silk, as was the skin.

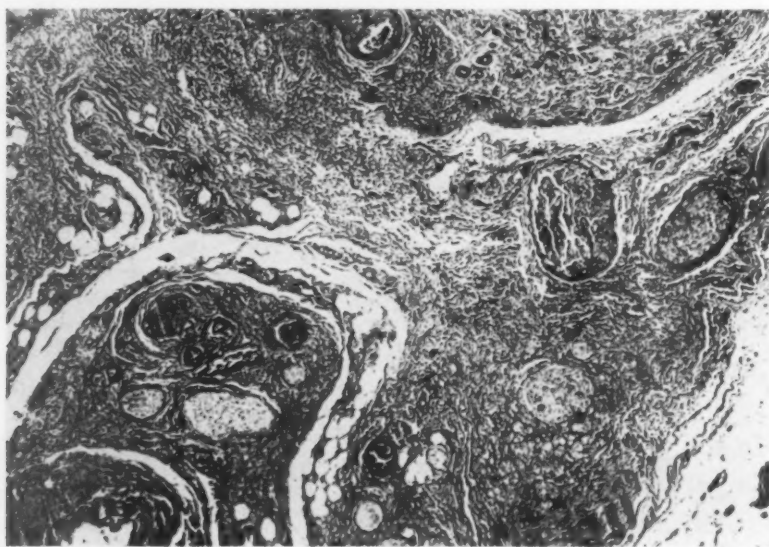


FIG. 6.—Case 2: Section taken through the remnant of the cystic duct near a fragment of the old chromic catgut ligature. Note the large nerve bundles and others such as seen in the lower right portion of the section, that are fragmented by scar formation.

The postoperative convalescence was uneventful.

Microscopic study of the portion of the cystic duct that was removed, showed a tremendous number of nerve fibers and trunks which were being invaded by an overgrowth of fibroblastic tissue, giving the classical picture of an amputation neuroma.

Case 2.—A. T., a white female, age 40, was first admitted into the Barnes Hospital, June 11, 1936, with a history that five years previously she had had sudden attacks of nausea followed by pain in the epigastrium which radiated to the midback. Jaundice later developed. This pain was relieved only by hypodermic injection. This was diagnosed as cholecystitis and a cholecystectomy was performed. Stones were said to have been found in the gallbladder at operation. She remained in the hospital for two weeks. Two days after returning home, she had a similar attack. Gastro-intestinal roentgenologic examination was then performed, but nothing abnormal was found.

Three years later she underwent a second operation in the same hospital, which supposedly was performed for adhesions which had been identified on roentgenologic

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examination. She again was in the hospital for two weeks. There were no attacks after her second operation for six weeks. Since then she had several attacks of pain in the epigastric region radiating to the back, associated with jaundice, fever, and clay-colored stools. Diet seemed to have no influence on the onset of these attacks. Since January, 1936, she had been having her stomach pumped every two weeks. The stomach contents were always bile-stained.

Physical examination upon her admission into the Barnes Hospital was within normal limits. The red blood count was normal, as was the white blood count and differential. Duodenal drainage was carried out and bile identified. Blood amylase was 93 units.

She was operated upon, June 20, 1936, by Doctor Heinbecker. The abdomen was opened through an upper right rectus incision and the stomach was found adherent to the old gallbladder site. There were numerous adhesions between the duodenum and the under surface of the liver. General exploration of the abdomen revealed no abnormalities. The stomach and duodenum were freed from the liver bed and the common bile duct exposed. It was found to be of normal size. Palpation did not reveal any stones. The pancreas was soft, apparently normal. The stump of the gallbladder, about one inch in length, had been left at the previous operation. This was removed from below upward. The cystic duct was small. It was tied off close to the common duct. There were no stones in this gallbladder remnant but its walls were thickened and the stomach and duodenum had been adherent to it. The abdomen was closed in layers.

Convalescence was uneventful, and she was discharged on July 6, 1936. Three months later a letter from the patient showed that there was not a great deal of improvement. However, a letter five months later from the patient's physician said that she showed marked improvement. The patient wrote two years later that she was now free from all symptoms, had gained 35 pounds, and was stronger than she had been in years.

Microscopic examination showed the cystic duct to be involved in a considerable amount of fibrous tissue, running through which were a large number of nerve trunks, many of which were splitting up into smaller groups, such as is seen in amputation neuroma. Surrounding the base of the whole mass was a small area of chronic catgut, which apparently had been present since the original operation. This ligature had apparently grouped all of the adjacent nerve fibers together in one mass of scar tissue.

Case 3.—Mrs. A. M., a white married woman, age 55, was first admitted to the Barnes Hospital on April 2, 1945. She complained of epigastric pain and severe vomiting. For some 10 or 15 years she had had intermittent epigastric pain coming on several hours after meals, which was relieved by taking food or milk. These episodes were more frequent in the Spring and Fall. There was not much change in these symptoms until November, 1944, when she began to vomit. Because at one time she vomited a small amount of blood, her physician suspected a peptic ulcer. She was also thought to have gallbladder disease. As a result she was operated upon on December 6, 1944. A local physician told her that adhesions prevented the gallbladder from being entirely removed but that several stones were obtained. Whether or not a partial cholecystectomy was performed we were never able to find out from the patient's record. Following operation she continued to vomit for several weeks and required intravenous fluids. During the past two weeks before admission she was unable to retain food in her stomach and had had intermittent epigastric pain and tenderness. This patient presented a complicated picture of obvious cholecystitis and a duodenal ulcer.

At operation, April 24, 1945, performed by Dr. Gordon Moore, the common bile duct was identified and seemed to be normal except for slight dilatation. The gallbladder remnant was extremely small, being only 2.5 x 1 cm. in diameter. With considerable difficulty the cystic artery and cystic duct were identified. The tiny gallbladder bed was peritonealized. It apparently represented only a small portion of the original viscus. The

common bile duct was opened and a probe inserted easily into the duodenum and into the two hepatic ducts, without evidence of obstruction. A T-tube was sewed in place. A duodenal ulcer was present but it was felt wise to delay further surgery.

The patient made an uneventful convalescence, and was completely relieved of all of her epigastric pain. She returned at a subsequent date for gastric resection, which was undertaken for the duodenal ulcer.

Since her discharge there has been no recurrence of the biliary colic.

Microscopic examination of the excised remnant of cystic duct showed marked thickening of the wall by virtue of fibrous tissue, and in this scar tissue was embedded numerous large nerve trunks, some of which were being split, such as is generally seen in an amputation neuroma in which the fibroblastic proliferation invades the nerve trunks.



FIG. 7.—Case 3: Large nerve trunks involved in scar in a fragment of the wall of a cystic duct remnant.

Case 4.—J. S., a 58-year-old married male, presented a history as follows: In 1941 he had had a cholecystectomy, with the removal of the gallbladder and stones. There had been preceding symptoms of biliary colic and dyspepsia for some 20 years. For one year after the cholecystectomy the patient had no symptoms. During the following two years he had four or five very severe attacks of right upper quadrant colicky pain which was referred to the right scapular region, which he describes as being typical in every respect to the colic he had had before his operation. These attacks of pain were not associated with chills, fever or jaundice.

During the recent months the pain has been less severe but the attacks more frequent. There has been very little dyspepsia between attacks and there is usually no nausea or vomiting during the attacks. He is able to eat almost any type of food. Physical examination showed a slightly obese male, with a large left indirect inguinal hernia, and an upper right rectus scar from the previous cholecystectomy. Blood pressure 140/94. The urine and blood cell studies were normal. The nonprotein nitrogen was 15 mg. per cent, fasting blood sugar 65 mg. per cent, icterus index was 10, urine contained no bile. Total plasma protein was 7.1, with albumin 4.3, globulin 2.8, and the blood amylase

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determination was 86 units. Cholecystography showed no visualization of the biliary apparatus. Electrocardiogram was within normal limits, cephalin flocculation tests 1 plus, the stool negative for blood and positive for bile.

The patient was admitted to the Barnes Hospital on February 10, 1946, and on February 14th, through an upper right rectus incision, removing the previous scar, the abdomen was explored. Considerable scarring was encountered in the peritoneal cavity and the dissection was made slowly. The duodenum was adherent to the under surface of the liver and was separated by sharp dissection. The head of the pancreas was identified and found to be relatively uninvolved by scar. The duodenum was mobilized and the common duct isolated. This was found to be slightly enlarged above the level of the origin of the cystic duct and somewhat smaller below this level. At the region of the origin of the cystic duct, there was a tendency toward hour-glass contraction, this being due to a nodular mass on the upper lateral surface of the common duct. The duct



FIG. 8.—Case 4: Nerve trunks in a hard mass of scar overlying the common bile duct. This tissue would be placed on tension with dilatation of the duct.

was entered and explored. No evidence of stones was found. The nodular mass was dissected off the common bile duct with a remnant of the cystic duct. The cystic artery was ligated separately. The lesion appeared grossly as an amputation neuroma of the nerves to the gallbladder. A T-tube was inserted and the defect closed over the T-tube in such a way that no narrowing of any considerable degree of the common duct was left. The tube was brought out through a stab wound and the abdomen closed in layers with figure-of-8 No. 30 steel wire.

The postoperative convalescence was uneventful and before his discharge cholangiograms were done, showing the common bile duct to be normal. The T-tube was left in place until 10-17-46, when the patient was readmitted into the hospital and the tube removed. During this interval the patient had had no attacks of pain or any of the previous symptoms for which the procedure was carried out, although the tube had been kept closed for some time. One month later the patient was still in excellent physical condition.

Microscopic examination showed the most important lesion to be the nodular mass previously described, intimately adherent to the common bile duct. This mass was composed of a conglomerate of nerve fibers involved in scar tissue and placed in such a position that any change in diameter of the common bile duct would produce stretching of these scarred fibers.

Case 5.—M. T., a 55-year-old farmer, was first admitted to the Barnes Hospital, February 5, 1945, at which time he gave a history of attacks of jaundice, right upper quadrant pain, vomiting, and fever which began about 1925. These symptoms became progressively worse so that he entered a hospital in a nearby city in 1942, at which time a cholecystectomy for stones was performed and the common bile duct explored. The gallbladder was subacutely inflamed and the common bile duct contained muddy material.



FIG. 9.—Case 5: Nerve trunks in scar tissue that was stripped from the anterior wall of the common bile duct.

The gallbladder was removed and a T-tube was left in place in the common bile duct. It was removed ten weeks postoperatively. Cholangiograms, taken at that time, showed what was said to have been a slight stenosis of the common bile duct. Following removal of the T-tube the patient's symptoms reappeared, with the exception that jaundice was questionable. He was readmitted to the same hospital, but no therapeutic procedures were recommended. He was unable to return to work and had not done so since the operation. He has numerous other complaints such as diarrhea, fatigability and dizzy spells. He had lost 25 pounds of weight during the preceding two months.

Physical examination showed a slight emphysema, heart sounds were faint, there was a healed abdominal operative scar, the prostate was symmetrically enlarged, the peripheral blood vessels were thickened, there was a fine tremor of the extended hands. Laboratory data showed the blood studies to be normal. The urine, stool, Kahn, icterus index, prothrombin time, blood sugar, blood nonprotein nitrogen, gastric analysis, spinal fluid, blood amylase, plasma protein, cephalin flocculation, and red blood cell fragility were normal. Four-hour glucose tolerance test was normal. Oral hippuric acid test showed a 69 per cent excretion. Stool examination showed no evidence of parasites, and allergy

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skin tests were essentially negative. The gastro-intestinal roentgenologic examination showed a questionable deformity in the prepyloric region, with diverticulosis of the sigmoid. Electrocardiogram showed bundle-branch block.

He was discharged from the Barnes Hospital, February 15, 1945, and was readmitted on April 9, 1946, with a story that his symptoms had not been improved by medical care and that he was still completely disabled. He was operated upon by Doctor Womack on April 17, 1946. The old scar in the upper right rectus region was excised and in many areas the peritoneum was found adherent to the skin. The peritoneal cavity was entered and the liver identified. The stomach was adherent to the liver, the pyloric region and antrum being brought upward at an acute angle which probably accounted for some of the deformities seen in the roentgenologic examination. These adhesions were separated, the duodenum isolated and mobilized by sectioning the lateral peritoneum. The old gallbladder bed was freed and the common bile duct isolated. It was approximately 2 cm. in diameter and thickened by several bands of dense fibrous tissue running across it in the region of the cystic duct. Because these bands might contain nerve fibers, they were dissected free from the wall of the common duct leaving the latter viscus a thin, bluish color when the dissection was complete. The duct was then opened and a lead probe passed through toward the duodenum. There was questionable resistance noted at the ampulla. A smaller probe was inserted and entered the duodenum easily. In order to establish the presence or absence of ampullary obstruction, an incision was made in the duodenum in the region of the ampulla. No obstruction was found. A diverticulum to the left of the ampulla, 1 cm. in diameter and 1 cm. deep, was identified, extending into the head of the pancreas. There was no ulceration about the diverticulum and no evidence of inflammation. A large probe was inserted through the common duct into the duodenum in order not to encroach upon the orifice, and the fundus of the diverticulum seized with clamps and inverted. The neck was ligated with a heavy silk suture. The duodenum was then closed. A T-tube was inserted into the common bile duct and the duct closed with interrupted silk. This tube was brought out through the abdominal wall by means of a stab wound and another small Carrel tube was placed along side it. The spleen was normal except for adhesions. The remainder of the gastro-intestinal tract was normal except the appendix which was long and contained two fecaliths. This was removed. The wound was closed with interrupted figure-of-8 sutures of No. 30 steel wire.

Since operation the patient has been free from his previous symptoms. The tube was removed one week after operation.

Microscopic examination showed that the heavy, fibrous tissue which overlay the anterior portion of the common bile duct and which was adherent to the peritoneum, consisted chiefly of large nerve trunks, through which bundles of collagenous fibrous tissue coursed. The position of this scarred nerve tissue was such as to be stretched whenever there was any dilatation of the common bile duct.

Case 6.—G. T., a 33-year-old married colored woman, was first admitted into the Barnes Hospital, July 17, 1945, with a history of vague right upper quadrant distress, with gaseous distention, nausea and vomiting since she was age 16. These attacks were never very severe and sometimes would not occur for as much as a year. The symptoms never lasted more than a day.

In June, 1943, at another hospital, she had been operated upon for gallbladder disease. At this time her common bile duct was obviously injured as the patient began to discharge bile immediately through her wound and later became jaundiced. Subsequently, she was reexplored but nothing apparently was done. At this time she began to have fairly severe attacks of upper right quadrant pain similar to biliary colic in every respect, much more pronounced than before her original operation. She was also deeply jaundiced, and there was no discharge of bile through her incision when we first saw her.

She was operated upon at the Barnes Hospital, July 27, 1945, at which time she

exhibited severe liver damage. The portal vein was identified, and a dense fibrous structure seen and felt which must have been the obliterated common bile duct. The distal part seemed hard and indurated and a small portion of the surrounding scar was removed for biopsy. After careful dissection, a gray, turbid bile was obtained from a point which proved to be a dilated common duct at the surface of the liver. This was opened and a fairly large amount of the same white bile, with inspissated mucus and other material escaped. This area proved to be the junction of the right and left hepatic ducts. In view of the poor condition of the patient and the marked liver insufficiency, a tube was inserted for temporary external biliary drainage until the function of the liver improved considerably. Anastomosis was to be performed at a second stage.

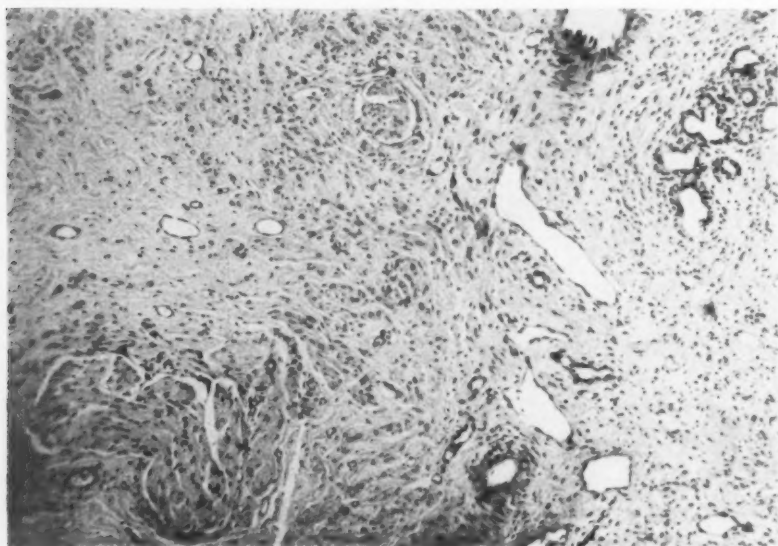


FIG. 10.—Case 6: Large and small nerve trunks adjacent to the dilated portion of a strictured common bile duct. This patient developed biliary colic after the formation of such scar. The colic was relieved after excision of the scar.

Unfortunately, her jaundice never disappeared. The secretion of bile became less and finally ceased completely. Another exploration showed the biliary obstruction to now be intrahepatic.

Microscopic examination of the tissue removed at operation from alongside the common bile duct shows large and small bundles of nerve fibers completely enmeshed in dense, fibrous tissue, producing a picture similar to that described in previous cases.

COMMENT: In the consideration of the anatomic and pathologic findings described in the preceding pages, there are certain aspects worthy of further comment. It is to be particularly noted that the size of the nerve bundles and the number of the nerve fibers distributed along the common bile duct and the cystic duct are sufficient to be of clinical significance. As has been pointed out, there is now sufficient clinical and experimental evidence obtained from observations on both animals and the human to demonstrate that stimulation

of these nerves results in symptoms identical to those experienced in biliary tract disease.

We have called attention to various types of lesions seen involving these nerve fibers in our experience with patients who have a persistence of their symptoms of biliary tract disease following cholecystectomy. As has been stated, attention has previously been called to the relationship of the persistence of a large cystic duct to the presence of such symptoms. We have also found this to be one of the common findings at operation. However, it is our feeling that it is not the persistence of a large cystic duct *per se* that produces disability, but rather the inclusion in the scarred walls of that duct of bundles of nerve fibers, chiefly sympathetic in type, with perhaps a smaller number of vagal fibers. At times, fibrous tissue proliferation and nerve trunk regeneration may result in a nodularity resembling the classical form of amputation neuroma. It will be recalled from the anatomic description of the distribution of these fibers, that both the anterior and posterior plexus tend to converge in the region of the cystic duct so that it is sometimes quite easy to include many of these fibers in the ligature about the cystic duct. At such a time there may not be true neuroma formation, but rather a constriction and ischemia of the nerve fibers in a region that is subject to variation in intra-ductal tensions during the day.

Another type of lesion noted in the nerve plexus has to do with the laying down of a diffuse sheath of dense fibrous tissue over the anterior surface of the common bile duct in the region of the stump of the cystic duct. Because of fear of injury to the common bile duct, this fibrous tissue is often not studied adequately. When it is removed and microscopic section made of it, in our experience it almost universally shows the same type of nerve trunks enmeshed in scar tissue as has been described above.

One of the most interesting observations in our experience has to do with that demonstrated in Case 6. Here was a thin young girl giving a clinical history that was not particularly suggestive of gallbladder disease, and certainly before her operation she had never complained of pain resembling that seen in biliary colic. Following the removal of what could easily have been a normal gallbladder, with subsequent damage to the common bile duct, there was sufficient scarring of the nerve supply to the common bile duct to result in a classical picture of biliary colic.

The presence of scar tissue around nerve trunks produces both stretching of the fibers and ischemia. Both of these factors, as has been well-demonstrated, lower the threshold of stimulation of nerve endings and nerve trunks. The presence of the damage, therefore, that has been described, is such as to make those nerve fibers present much more susceptible to stimulation, and what in a normal environment would be a stimulus so mild as to be clinically imperceptible, could now become one with considerable exaggeration. It would seem to us that the position of these damaged fibers about the expanding and contracting common bile duct and occasionally the cystic duct, is adequate to explain the origin of this stimulus.

Another interesting feature about this study has been the time element. As a general rule, several months usually elapse after the cholecystectomy before the recurrence of symptoms begins to appear. This would be in keeping with the laying down of the dense collagenous scar. Furthermore, we are familiar with many instances in which these postcholecystectomy symptoms have appeared and after a few years disappeared. This we would interpret as being due to complete degeneration of the damaged nerve trunks.

In order to prevent the appearance at a later date of such symptoms as have been described, it has been our practice for some time now, wherever possible, to separate the nerve trunks mesial to the common bile duct. In most instances, this is fairly easily done if the peritoneum and underlying areolar tissue is removed from over the common bile duct before the gall-bladder is resected. The nerve trunks can then be well-visualized and lifted up with a blunt clamp and sectioned. At the same time, the common bile duct is cleaned of all surrounding areolar and fibrous tissue. Occasionally, a situation develops in which such treatment of the common bile duct would be fraught with considerable danger. At such times, it has been our experience that the best treatment has to do with stripping completely the cystic duct of all of its adjacent structures as well as the cystic artery. In this way, none of the nerve fibers are caught in the ligature.

In those patients that have been operated upon for the so-called postcholecystectomy syndrome, a similar plan of procedure is carried out. At this time, whenever present, the stump of the cystic duct is removed close to the common bile duct. Any scarring present on the surface of the common bile duct is carefully removed. The nerve trunks, as a rule, become well-visualized on the mesial side of the common bile duct and can likewise be destroyed at that time.

SUMMARY

1. From 5 to 20 per cent of patients with characteristic symptoms of cholecystitis, and with the classic pathologic findings at operation, will continue to have their symptoms in varying degrees of severity following cholecystectomy.

2. Considerations previously advanced as to the cause of the persistence of these symptoms have been discussed.

3. The nature of the nerve supply to the bile passages is described, and pathologic lesions seen in these nerve pathways in patients with persistent symptoms following cholecystectomy are demonstrated.

4. Effective prevention and treatment is outlined.

REFERENCES

- ¹ Judd, E. S.: Clinical versus Pathologic Cholecystitis. *Coll. Papers Mayo Clinic*, 17, 152-156, 1925.
- ² Whipple, A. O.: Surgical Criteria for Cholecystectomy. *Am. J. Surg.*, 40, 129-131, 1926. (Quoted from Mueller³)
- ³ Mueller, G. P.: The Noncalculus Gallbladder. *J. A. M. A.*, 89, 786-789, 1927.
- ⁴ Finsterer, H.: Unmittelbare Erfolge und Dauerresultate der operativen Behandlung des Gallensteinleidens. *Wien. klin. Wchnschr.*, 48, 966-971, 1935.

SYMPTOMS FOLLOWING CHOLECYSTECTOMY

- ⁵ Elman, R.: Common Problems in Surgical Diagnosis. *S. Clin. N. Am.*, **20**, 1247-1260, 1940.
- ⁶ Parsons, W. H.: Immediate and End-results after Cholecystectomy. *ANNALS OF SURGERY*, **111**, 831-837, 1940.
- ⁷ Graham, E. A., and Mackey, W. H.: A Consideration of the Stoneless Gallbladder. *J. A. M. A.*, **103**, 1497-1499, 1934.
- ⁸ Ivy, A. C., and Sandbloom, P.: Biliary Dyskinesia. *Ann. Int. Med.*, **8**, 115-122, 1934.
- ⁹ Westphal, K.: Muskelfunktion, Nervensystem und Pathologie der Gallenwege. *Ztschr. f. klin. Med.*, **96**, 22-50, 1923.
- ¹⁰ Weir, J. F., and Snell, A. M.: Symptoms that Persist after Cholecystectomy. *J. A. M. A.*, **105**, 1093-1098, 1935.
- ¹¹ Zollinger, Robert: Observations following Distention of the Gallbladder and Common Duct in Man. *Proc. Soc. Exper. Biol. & Med.*, **30**, 1260-1261, 1932-33.
- ¹² Puestow, C. B.: Changes in Intracholedochal Pressure following Cholecystectomy. *Surg., Gynec. and Obst.*, **67**, 82-86, 1938.
- ¹³ Benson, K. W.: Dilatation of Bile Ducts and its Relation to Distress after Cholecystectomy. *Am. J. Digest. Dis.*, **7**, 1-2, 1940.
- ¹⁴ Schrager, V. L., and Ivy, A. C.: Symptoms Produced by Distention of the Gallbladder and Biliary Ducts. *Surg., Gynec. and Obst.*, **47**, 1-13, 1928.
- ¹⁵ Davis, Loyal, Hart, J. T., and Crain, R. C.: The Pathway for Visceral Impulses within the Spinal Cord. *Surg., Gynec. and Obst.*, **48**, 647-651, 1929.
- ¹⁶ Butsch, W. L., McGowan, J. M., and Walters, Waltman: Clinical Studies on the Influence of certain Drugs in Relation to Biliary Pain and to the Variations in Intrabiliary Pressure. *Surg., Gynec. and Obst.*, **63**, 451-456, 1936.
- ¹⁷ Doubilet, Henry, and Colp, Ralph: Resistance of the Sphincter of Oddi in the Human. *Surg., Gynec. and Obst.*, **64**, 622-623, 1937.
- ¹⁸ Beye, H. L.: Conditions Necessitating Surgery after Cholecystectomy. *Surg., Gynec. and Obst.*, **62**, 191-202, 1936.
- ¹⁹ Gray, H. K., and Sharpe, W. S.: Biliary Dyskinesia: Rôle Played by Remnant of Cystic Duct. *Proc. Staff Meet. Mayo Clinic*, **19**, 164-168, 1944.
- ²⁰ Womack, N. A.: Pathologic Changes in Chronic Cholecystitis and the Production of Symptoms. *Surgery*, **4**, 847-855, 1938.
- ²¹ Dogiel, A. S.: Über den Bau der Ganglien in den Geflechten des Darmes und der Gallenblase des Menschen u. der Säugetiere. *Arch. f. Anat. u. Physiol., Anat. Abth.*, 130-158, 1899.
- ²² Raigorodsky, J. L.: Die Nerven der Leberpforte des Menschen. *Ztschr. f. Anat. u. Entw.*, **86**, 698-730, 1928.
- ²³ Eiger, M.: Der sekretorische Einfluss des Nervus vagus auf die Gallenabsonderung. *Ztschr. f. Biol.*, **66**, 229-279, 1916.
- ²⁴ Kuntz, Albert: The Autonomic Nervous System. 231-232. Lea and Febiger, Philadelphia, 1929.
- ²⁵ de Takats, Geza: Splanchnic Anesthesia; Critical Review of Theory and Practice of this Method. *Surg., Gynec. and Obst.*, **44**, 501-519, 1927.
- ²⁶ Greving, R.: Die Innervation der Leber. *Die Lebensnerven.* (L. R. Mueller), 272-287, 1924.
- ²⁷ Rio-Branco: Essai sur l'anatomie et la médecine opératoire du tronc coeliaque. Paris, 1912.
- ²⁸ Latarget, Paul Bonnet, Bonniot, Albert: Les nerfs du foie et des voies biliaires. *Lyon chir.*, **17**, 1-39, 1920.
- ²⁹ Labat, Gaston: Regional Anesthesia: Its Technic and Clinical Application. p. 371. W. B. Saunders & Co., Philadelphia, 1924.
- ³⁰ Morley, John: Abdominal Pain. William Wood & Co., New York, 1931.

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BEZOARS CAUSING ACUTE INTESTINAL OBSTRUCTION*

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A BEZOAR is currently described as a concretion usually found in the stomach or intestines of certain ruminates and is composed of various vegetable matters, hair, *etc.* The composition of the bezoar determines its class, namely, trichobezoar composed mostly of hair; phytobezoar composed of vegetable matter; and (3) trichophytobezoar, a combination of these two.

In the 58 years of this association there has been only one paper presented before it dealing with the subject of bezoars. This was presented in a most interesting and instructive paper by Dr. Rudolph Matas,¹ in 1914. This presentation dealt exclusively with the trichobezoar, or hair balls, in the stomach, special attention being directed toward the preoperative diagnosis of this condition by means of the contrast media and roentgenograms. At the time of this paper there were 73 reported cases in the literature to which the author added one of his own. In the "Supplementary Commentaries on Bezoars" at the end of this article Doctor Matas writes in his own inimitable way concerning the history of bezoars and the important part they played in the "pharmacopeia of antiquity and of the middle ages, even up to the eighteenth century."

We have said that this subject has been presented only once before this association, at the same time it should be noted that the most exhaustive and recent study of the subject is by two members of this association, Dr. Alton Ochsner and Dr. Michael DeBakey.^{2,3} This study comprises a thorough search of the world literature up to 1938, at which time there were 171 cases of trichobezoars, 119 cases of phytobezoars and 13 cases of other concretions. This plus their seven additional cases comprised a total of 126 phytobezoars and because of the fact that 92, or 73 per cent, of these bezoars were due to the ingestion of persimmons they suggested the term "diospyrobezoar" from the Greek *diospyron*, translated as "Jove's grain," the generic term for the wild persimmon.

The most recent report on the bezoars that we have been able to find in the literature is by Miller and Kert,⁴ on "Trichobezoar," from the Journal of the Mt. Sinai Hospital, April, 1944. These writers report three cases occurring in Mt. Sinai Hospital, two being intragastric, while the third suffered from combined gastric and multiple intestinal trichobezoars. This last patient died, whereas the other two recovered.

It is to be noted that in the eight cases of bezoars reported by DeBakey and Ochsner only one was composed of hair and seven were composed of

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vegetable matter, mostly the wild persimmon, whereas in three cases reported from Mt. Sinai Hospital all were composed of hair. This difference is no doubt accounted for by the geographic difference between New Orleans, in the South, where the wild persimmon flourishes and New York, in the East, where this fruit grows sparsely, if at all.

While the composition of bezoars can be easily determined and the reason for the ingestion of the vegetable matter causing most phytobezoars is easily understood, the reason or reasons for trichophagia remains a mystery. In cases of trichobezoars where sex was noted 139 were female and 13 were male. This would suggest that the long hair of the female is certainly one of the underlying causes. However, "when the incidence was listed by decades and the long or short hair style of the decade is noted, no significant variation is apparent."

In the case of phytobezoar the records show about 3 to 1 in favor of the male.

Trichobezoars are found most frequently between the ages of 10 and 19, whereas the phytobezoars are found most frequently between the ages of 50 and 59.

Throughout the literature the emphasis is placed on the diagnosis and treatment of gastric bezoars. In some reports mention is made of the fact that portions of the trichobezoars may break off, producing intestinal obstruction, and the operator is cautioned about examining the bowels for these cast-offs when removing one from the stomach. However, very few cases of obstruction have been reported. In discussing Doctor Matas' paper Dr. Le-Grand Guerry mentioned a case in his practice of acute intestinal obstruction caused by one of these.

In Matas' report six of 44 operated cases had hair balls in the intestines but none of these seem to have caused acute obstruction.

DeBakey and Ochsner also mention the "possibility of such complications as intestinal and gastroduodenal ulceration, with consequent hemorrhage, perforation and peritonitis."

While the diagnosis of intragastric bezoars, especially trichobezoar, may often be made preoperatively the same is not true once the bezoar has passed into the intestinal tract and produced obstruction. The case then presents the usual picture of acute intestinal obstruction, the cause of which may only be suspected if there is a suggestive history. In the eight cases reported by DeBakey and Ochsner there were three cases of intestinal obstruction caused by phytobezoars of persimmon origin. A definite history of having eaten persimmons prior to the onset of illness was obtained in two of the three cases; in one case only a few days before, whereas in the other 11 months had elapsed. In both cases the cause of the obstruction was predicted before operation.

Heffels⁵ reports a case of high obstruction in a 56-year-old woman suffering from schizophrenia.

In the three cases that have come under our observation the bezoars were all found in the small bowel, causing acute obstruction. Two of these were phytobezoars and one a trichobezoar. We must admit that we failed to determine the etiologic factor before operation in any of the three cases, whereas it should have been suspected in two of the three. In Case 2 and 3 a history of having eaten persimmons and a history of trichophagia, respectively, were obtained following operation.

CASE REPORTS

Case 1.—The first case is that of a white male, age 73, admitted to the hospital complaining of pains in the abdomen, nausea and vomiting.

Present Illness.—The patient began having colicky pains in the abdomen four days before admission. Twenty-four hours later he became nauseated and vomited. The pain continued mostly in the right side and each day there was continued, but not frequent, nausea and vomiting. There had been no movement of the bowels.

Physical Examination.—This revealed an elderly white man, age 73, in poor physical condition. The temperature on admission at 10:00 A.M. was 98° F., pulse 120, quite irregular. B.P. 110/90. The heart sounds were distant, feeble and irregular. The abdomen was distended, especially in the lower half, while the skin over the right lower quadrant was blistered from hot applications. No mass was palpable but there was definite tenderness over McBurney's point and below. *Laboratory Data.*—These showed a normal urine. N.P.N. 35 mg. W.B.C. 13,500, polys 84 per cent. Hb. 90 per cent. *Preoperative Diagnosis:* Acute intestinal obstruction of undetermined etiology.

Treatment: The patient's condition on admission would not permit immediate operation, but following saline infusions this improved to such an extent that operation under local anesthesia was undertaken eight hours later.

Operation.—Under local anesthesia of 1 per cent novocaine, a low right rectus incision was made. A moderate amount of straw-colored peritoneal fluid was present. The appendix was normal. There was a moderate distention of the small bowel leading to a mass in the pelvis which, when pulled up into the wound, proved to be within the lumen of the lower ileum. The abdominal cavity was carefully packed-off with moist gauze packs and the mass removed through a two-inch incision in the free border of the bowel. The bowel was then closed with two layers of fine catgut and the abdominal wound in layers, without drainage.

Pathologic Report.—"The specimen is a mass of greenish-black substance, measuring 5 x 3 x 2.5 cm., which when cut is found to be composed of dried vegetable fibers." There was nothing in this report to identify the specimen as of persimmon origin.

The convalescence in this case was rather stormy because of wound infection, but he was dismissed from the hospital on the 16th postoperative day, in good condition.

Case 2.—The second case was that of a white male, age 60, admitted to the hospital, March 27, 1939, complaining of pain in the abdomen, nausea and vomiting.

Present Illness.—For about one year the patient had complained of epigastric discomfort, especially following meals, and had been under treatment for supposed duodenal ulcer, although there had been no roentgenologic studies. The day prior to admission to the hospital he was seized with severe abdominal cramps, especially in the upper part, accompanied by severe nausea and vomiting.

Physical Examination.—This showed the patient to be a well-developed man, age 60, apparently suffering acutely. Pulse 84, temperature 99.4° F., B.P. 146/82. Heart and lungs normal. Urine normal except for a trace of acetone and diacetic acid.

BEZOAR OBSTRUCTION

Interest centered chiefly on the abdomen, but, even here, there was nothing very striking—only moderate distention in the upper half associated with a moderate amount of tenderness, no spasm and no palpable mass.

In view of the uncertainty of the diagnosis roentgenologic examination was made, with the following report: "Fluoroscopic survey of the chest showed no pathology of heart or lungs. Plain film of the abdomen showed no distended loops of bowel. A barium meal was given. The esophagus, stomach and duodenum were normal. Five hours later examination showed a complete obstruction to the passage of barium at a point in the jejunum about 12 inches distal to the ligament of Treitz. No barium passed this point. A recheck two hours later showed no change." *Preoperative Diagnosis:* Complete, high intestinal obstruction of unknown etiology.

Operation.—Through an upper right rectus incision the abdomen was opened, and the jejunum, containing a firm rounded mass, was delivered onto the abdomen. The abdominal cavity was packed-off carefully with warm moist packs and intestinal clamps



FIG. 1.—Trichobezoar which produced complete small bowel obstruction. Removed from lower ileum.

applied. The bowel above the mass was moderately distended while that below was flat. Through a longitudinal incision on the free surface of the bowel the mass was removed and the wound closed with three layers of suture. The abdomen was closed in layers, without drainage.

Pathologic Report.—The pathologist described the specimen as a large mass roughly triangular in shape, measuring $6 \times 4 \times 4$ cm.: through its thickest portion it was 4 cm. It had a putrefactive, fecal odor and was covered by a dirty greenish-grey film. When sectioned, the interior of the mass was brownish in color and in it were masses of vegetable and fruit peelings and many seeds.

Postoperative questioning of the patient revealed that he had eaten heartily of persimmons, which grew plentifully on his farm.

End-Result: Complete, uneventful recovery.

Case 3.—The third case is that of a white female, age 5, presented by her mother, with the chief complaint of nausea, vomiting and abdominal pain.

Present Illness: For the past six months the child had been complaining of anorexia, and during the past three months with intermittent attacks of constipation, abdominal pain, nausea and vomiting. On the day of admission these symptoms became more marked, and were associated with elevation of temperature and pulse.

Physical Examination: This revealed a rather thin, pale, white girl, age 5. Temperature 100.4° F. Pulse 120. Other physical findings were within normal limits except for generalized abdominal distention and tenderness without rigidity. There was some voluntary muscle spasm in the right lower quadrant but not enough to prevent palpation of an elongated mass, which was about the size of a man's thumb. This mass lay approximately midway between the umbilicus and right anterior superior spine, moderately sensitive to palpation, and slightly movable. No roentgenologic studies were made since the case was one for immediate surgery. *Blood count:* W.B.C. 14,000, polys. 84 per cent. *Preoperative Diagnosis:* 1. Acute appendicitis. 2. Intussusception.

Prior to operation foreign body was not even considered in this case. An acutely inflamed appendix wrapped in omentum may give a similar picture. Intussusception was considered as a possibility because of the movable, elongated mass, although there had not been any blood in the stools and the child was above the age when this usually occurs.

Operation: This was done through an extended McBurney incision. There was an excessive amount of straw-colored peritoneal fluid, and immediately beneath the incision appeared a large, elongated firm mass within the lower ileum. The loop of bowel containing the mass was easily delivered onto the abdominal wall, the abdominal cavity was



FIG. 2.—Same as Fig. 1. Note constriction, probably caused by pyloric muscle before final expulsion from the stomach.

carefully packed-off with warm moist gauze and a two-inch longitudinal incision was made along the free border of the bowel exposing and delivering a foul-smelling mass of matted hair, measuring 9 x 3 x 3 cm., and retaining roughly the contour of the stomach (Figs. 1 and 2). The bowel was closed with two layers of fine catgut suture, and the abdominal wound closed in layers, without drainage.

Postoperative Diagnosis: Trichobezoar, causing complete obstruction. Recovery was uneventful and, as far as we have been able to determine from the mother, this experience has cured the child of eating hair. Following the operation the mother, when questioned, stated that she had never actually seen the child eating hair but had frequently noted loose hairs in the bed and bald spots on her scalp since infancy, but had never attached any significance to it.

In our search of the literature we have been unable to find a recorded case in which a trichobezoar has passed out intact through the pylorus into the lower bowel, resulting in obstruction, all the other acute intestinal obstructions from trichobezoars were caused by fragments that had broken off from a gastric bezoar and passed through the pylorus.

BEZOAR OBSTRUCTION

SUMMARY

1. A brief review of the literature on the bezoars is given.
2. Two cases of phytobezoars and one of trichobezoar are added.
3. All three cases were causing acute intestinal obstruction, were operated upon, and all recovered.

REFERENCES

- ¹ Matas, Rudolph: Hair Balls or Hair Cysts, of the Stomach and Gastro-Intestinal Tract. *Southern Surgical and Gynecological Transactions*, **27**, 572, 1914.
- ² DeBakey, Michael, and Ochsner, Alton: Bezoars and Concretions. *Surgery*, **4**, 934-963, 1938.
- ³ DeBakey, Michael, and Ochsner, Alton: Bezoars and Concretions. *Surgery*, **5**, 132-160, 1939.
- ⁴ Miller, David, and Kert, Morley: Trichobezoar, J.: Mt. Sinai Hospital, **10**, 782-788, March-April, 1944.
- ⁵ Heffels, H.: Intestinal Obstruction by Trichobezoar. *Psychiat.-Neurol. Wechnshr.*, **38**, 278, June 6, 1936.

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DISCUSSION.—DR. JOSEPH W. COLLINS, Portsmouth, Va.: In 1938 I had the privilege of reporting a case of recurrent trichobezoar before this Association. The patient was a young girl, age 7, who had a palpable tumor in her upper abdomen. Her mother said that she had appeared to be a normal infant in all respects, but as soon as she started to crawl she began to pick up foreign bodies and swallow them. These consisted of hair, strings, tacks, match sticks, pins and small pieces of glass, paper, chicken feathers and, in short, whatever she could put her hands on. Her mother found many of these objects in her stools. At the age of two she began to pull her own hair and swallow it. This strange appetite continued and, at the age of five, she began to lose weight and complain of pain in her upper abdomen. Her appetite for food was poor. She had frequent attacks of nausea and vomiting. These symptoms persisted until her admission to the hospital.

Operation revealed a large hair ball completely filling her stomach. There was a prolongation of it through the pylorus and duodenum into the jejunum for a distance of 13 inches. The pyloric opening was greatly dilated, but no gross pathologic lesions were encountered. This hair ball weighed one pound, eight ounces, and was S-shaped, forming a mold of the stomach, duodenum and part of the jejunum. The mass consisted chiefly of hair, but many other foreign bodies were also evident.

When this child reacted from her anesthetic she began to beg for food. Her demands were so insistent and so noisy that it was necessary, for the comfort of other patients, to keep her completely narcotized until mouth feeding could be safely resumed. She made an uneventful recovery.

Eight years later she was again admitted to the hospital because of pain in the upper abdomen. She was now a girl of 15, and had been attending high school until she was forced to leave school because of her illness. The pain in the abdomen was more or less constant, but at times it became a severe colic. These symptoms began about four months before admission. Her condition had grown steadily worse since onset of symptoms, and her weight had dropped from 128 pounds in September, 1934, to 99 pounds upon admission. In the light of her history and physical examination it was plainly evident that she had accumulated another hair ball. Roentgenologic examination, after administration of barium meal, showed the stomach to be completely filled with a solid mass. Her abdomen was again opened and a large, twisted, S-shaped hair ball was removed; this weighed one pound, two ounces, and completely filled the stomach and duodenum. It

consisted almost entirely of black hair. In the first part of the jejunum, about seven inches from the duodenojejunal junction, three small hair balls could be palpated. One of these had a very sharp edge which had ulcerated through the wall of the intestine. This perforation was covered by the omentum. A portion of the proximal end of the jejunum and its mesentery was much indurated and inflamed, and there were numerous enlarged, inflamed mesenteric nodes in this region. With this extensive pathologic condition in the jejunum it was deemed advisable to resect the damaged portion rather than attempt to repair the perforation. Resection of the damaged segment and side-to-side anastomosis was therefore performed. The resected intestine contained the three small hair balls. Immediately distal to the inflamed portion of the jejunum there was an intussusception. This was apparently of recent origin and was easily reduced. The abdomen was closed without drainage, and again the patient made an uneventful recovery.

Upon reviewing the literature I found only three other cases reported in which there had been a recurrence. One of these was a woman who had had five hair balls removed.

DR. JAMES D. RIVES, New Orleans, La.: If I may be permitted a certain amount of flexibility in the use of the term bezoar, I would like to report another of these curious cases. This was a white female child, six years of age. She was undernourished and somewhat mentally deficient. Roentgenologic examination showed the duodenum to be about the same size as the stomach, and to contain a number of assorted foreign bodies.

At operation, the duodenum was opened, and an heterogeneous accumulation of odds and ends was removed; it included leaves, paper, seeds of various kinds, buttons, and a coin. One ring, visualized roentgenologically, could not be found, and presumably was passed per rectum. At the time, I believed that the duodenal dilatation was due to this mass of foreign material, and thought its removal was sufficient. However, she returned after one year with an equally ill-assorted collection of material in the duodenum, and roentgenologic examination suggested the existence of duodeno-mesenteric ileus. It became apparent that since nothing could be done about her eating habits something must be done about the disposal of what she swallowed. At operation, a large amount of foreign material similar to that removed at the first procedure, was found and removed. A very large duodenojejunosomy was made.

This procedure seems to have been successful since, while she continues to swallow anything she can lay her hands on, all of it has so far passed through the intestinal tract.

DR. J. M. DONALD, Birmingham, Ala.: Doctor Watt has presented to us a most interesting subject.

I would like to report a case of phytobezoar (persimmon ball) of the stomach, with a perforated gastric ulcer as a complication. This case has not been previously reported. I have been unable to find a similar case in the literature.

Case Report.—This 27-year-old white male was admitted to the surgical service of the Hillman Hospital on February 9, 1936. He gave a history of having noticed epigastric pain for the past three weeks. The pain developed several hours after meals and was relieved by food. For the past two weeks tarry-colored stools were noticed. There was no history of previous attacks. Six days before admission he began to vomit dark brown material and the epigastric pain increased. Approximately 19 hours before coming to the hospital, and after taking a large dose of Epsom salts, he developed severe epigastric pain requiring morphine for relief. The picture on admission was that of acute perforation of a peptic ulcer, with peritonitis, and a respiratory infection.

Immediate exploration, under spinal anesthesia, revealed a generalized peritonitis due to a large perforation of a gastric ulcer situated on the anterior wall of the stomach in its middle third. A large, firm mass was palpated floating in the stomach contents. The stomach was opened and a large phytobezoar was removed. It weighed 3.5 ounces and measured 10.5 x 5.5 x 4.5 cm. It was stained black and had assumed the shape of the stomach. The defect in the stomach was closed in layers and the abdomen was closed, with drainage. While on the operating table the patient gave a history of having eaten a hat full of persimmons in one sitting, in the Fall preceding operation.

BEZOAR OBSTRUCTION

Death from peritonitis and bilateral lobar pneumonia occurred two days after operation.

It was our opinion that the gastric ulcer was caused primarily by the mechanical irritation of the gastric mucosa by the persimmon ball.

DR. CHARLES H. WATT, Thomasville, Ga., (closing): I want to thank you for this discussion and I also wish to apologize to Doctor Collins for having overlooked the report of his case. I note he reported it before this Association in 1938.

SURGICAL CURE OF URINARY INCONTINENCE IN WOMEN*

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INCONTINENCE OF URINE of varying degree in women is one of the common complaints heard in every gynecologic clinic. When the symptom is of a marked degree, there is nothing more distressing to the patient. Not only is there the physical discomfort associated with constant moisture and local irritation, but there is an unmistakable odor of decomposing urine which is annoying to the patient and those in proximity to her. The constant fear of visibly wetting her outer clothing is trying on her nerves and she may shun society and ultimately lead the life of a recluse.

To talk to these victims is to be convinced that no surgeon can do a more humane act than give them relief. Unfortunately, surgical results, in general, are not as satisfactory as they should be. The great numbers of women who seek relief at the larger clinics, after numerous previous unsuccessful operative attempts, amply support this statement. There are many reasons for these failures. One of the principal reasons is our lack of knowledge of the exact anatomy of the parts and our failure to know completely the physiology of micturition. Another is the lack of training in female urology of surgeons, gynecologists and obstetricians who attempt plastic operations to restore continence. The necessary skill to cystoscope, and thus examine the bladder and urethra from within, is a great advantage to the surgeon from a diagnostic and surgical point of view. Because the symptoms of incontinence are so distressing, the patient urges the doctor to cure her promptly. Since the surgeon or obstetrician often feels a sense of guilt in having had a hand in causing the condition, he may yield and operate too soon, before sufficient time has elapsed to get the tissues in condition for plastic surgery.

We have had rather extensive experience in urinary incontinence in the female at the Gynecological Clinic of the Johns Hopkins Hospital, where a division of female urology is an integral part of the clinic. It was thought that our experience of the past decade might be reviewed so that we can profit in the future from our mistakes and experiences in the past. This paper is concerned with such a review.

The types of incontinence considered in this series are briefly summarized below. It is conceded that there are other rare types, such as those due to extrophy of the bladder and ectopic ureters opening into the vagina or urethra, but they each require special consideration and are not included in this series.

* Read before the 58th Annual Session of the Southern Surgical Association, Hot Springs, Va., December 11, 1946.

URINARY INCONTINENCE IN WOMEN

1. *Stress incontinence* of different degrees, varying from slight, occasional loss of control on severe straining at coughing, sneezing or lifting heavy weights to almost complete incontinence which occurs with the slightest exertion. Stress incontinence is usually associated with cysto-urethrocele, with or without uterine prolapse, but occasionally is seen without these conditions, and even in nulliparous (usually elderly) women.

2. *Vesicovaginal fistulae*, due to childbirth injuries, surgical injuries and destruction of the vaginal and bladder walls by malignant disease of the pelvic organs and/or irradiation therapy.

3. *Defects in the urethra and sphincters*, due to congenital defects, obstetrical and surgical accidents, or destruction by malignancy or lymphopathia venereum.

4. *Incontinence due to neurologic disease*, such as spina bifida, multiple sclerosis or tabes dorsalis.

5. *Ureterovaginal fistulae*, due to operative or irradiation injuries.

6. *Inflammatory lesions of the urinary tract*, causing such marked frequency and urgency as to result in practical incontinence. No cases of this type are included in this series because, strictly speaking, they should not be classified as incontinence and their treatment, obviously, is not surgical. However, it is extremely important that they be recognized and differentiated from those cases in which there is a defect in the sphincter mechanism or bladder or ureteral walls. A careful history will usually identify this group, but cystoscopic examination should often be done for confirmation.

STRESS INCONTINENCE

The causes and cure of stress incontinence will be considered first. It is many times more frequent than all of the other types combined. It is the simplest type to cure surgically and yet results are not uniformly satisfactory. Kelly and Dumm¹ reported 80 per cent successful; B. P. Watson² 65.7 per cent and H. Dawson Furniss³ 76.5 per cent.

There is more than one etiologic factor in stress incontinence. This was recognized as early as 1913 by Kelly,⁴ who noted that some cases occurred in association with cystocele and others occurred without any visible lesion. B. P. Watson found that two out of every three women with stress incontinence had cystocele, and our experience coincides with his.

The explanation for the incontinence in those cases associated with cysto-urethrocele or urethrocele lies in the sagging of the urethra and base of the bladder. It is the sagging of the urethra and the immediately adjacent trigone rather than the higher portion of the bladder which is the chief factor in loss of control. In many cases of cystocele and/or uterine prolapse when the urethra maintains its normal position snugly attached beneath the symphysis there is no incontinence. Defects in the pubovesicocervical fascia, which normally supports the urethra and bladder, are responsible for both urethrocele and cystocele. Coughing, sneezing and other physical exertion forces the unsupported undersurface of the urethra and bladder downward, while the

anterior surface remains in apposition to the symphysis. This prevents the urethral sphincter muscles from closing in a normal concentric manner and the resulting oval sphincter aperture fails to completely shut off the flow of urine (Fig. 1). The gush of urine can be prevented in most of such cases by making slight pressure against the undersurface of the urethra when the patient coughs, thus, giving the urethra the support which it normally gets from the intact pubovesicocervical fascia.

The women without cysto-urethrocele usually present themselves after middle age, and the only explanation which can be offered is a decrease in

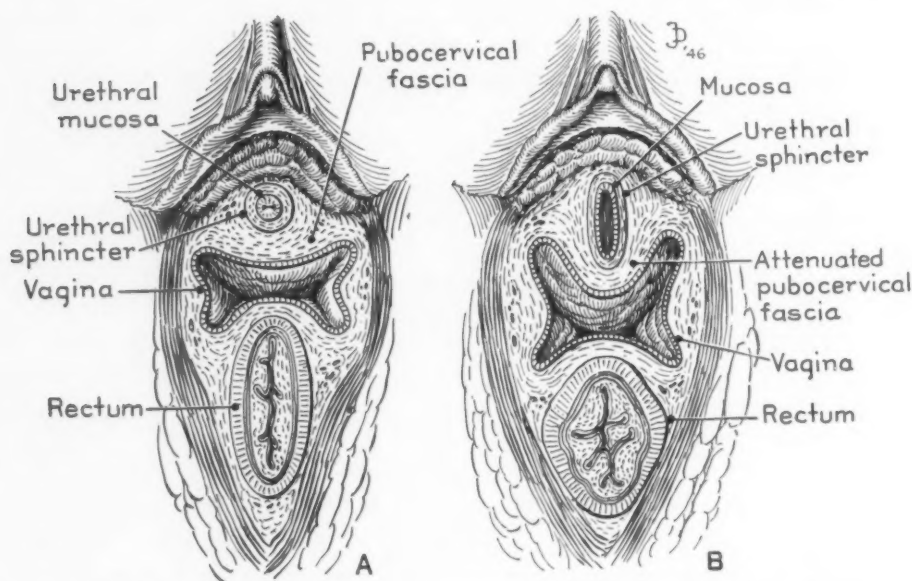


FIG. 1.—A. Schematic representation of camera shutter-like action of normal urethral sphincter.

B. Schematic representation of failure of urethral sphincter to close on straining after development of urethrocele.

sphincter muscle tone occurring with advancing years. However, it is difficult to prove this assumption, even by inspecting the urethral sphincters cystoscopically. The smaller percentage of cures obtained by sphincter plication in this group would seem to substantiate the view that the musculature is not up to par.

There is still another group of women who suffer from stress incontinence. These women may have had one or more vaginal deliveries or unsuccessful operations for stress incontinence. Indeed, the loss of control may follow operations for cysto-urethrocele in women who had no previous incontinence. The author has had two such instances in his practice, and Kennedy⁵ has reported similar cases. The explanation lies in the formation of scar tissue in the periurethral region, preventing the camera shutter-like action of the sphincter

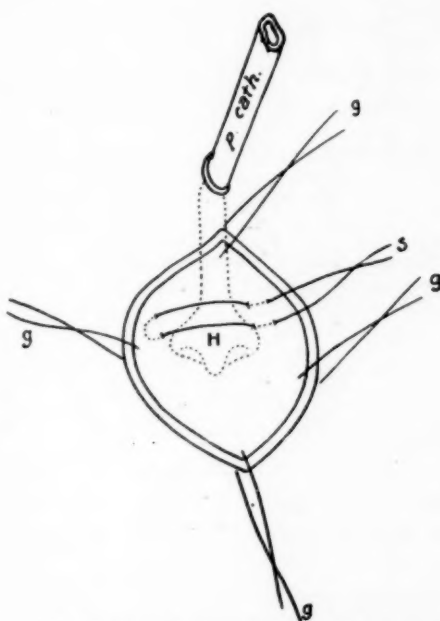
URINARY INCONTINENCE IN WOMEN

muscles. Visualization of an imperfect closure can, in some instances, be demonstrated cystoscopically. Kennedy⁵ has particularly stressed the importance of these periurethral adhesions and has devised an operation for the restoration of continence in such cases. His operation will be discussed later.

OPERATIVE PROCEDURES FOR CURE OF STRESS INCONTINENCE

The procedures for the cure of stress incontinence are the plication of the vesical sphincter musculature and reuniting the pubovesicocervical fascia fibers beneath the urethra and base of the bladder. Plication of the vesical sphincter was probably first done by Howard Kelly, although all authors do not agree on this. Schumann,⁶ for example, states: "The best procedure for this purpose in my experience is a modification of that proposed by Baldy, in 1913, and afterward described by Kelly, by whose name the operation is most generally known." This difference of opinion stimulated the author to investigate the records on the subject and the facts in the literature are as follows: In 1913, Baldy⁷ reported on two patients with stress incontinence which he cured by denuding an oval of vaginal mucosa and the underlying fibrous tissue beneath the neck of the bladder and closing the wound with interrupted silkworm gut sutures. In making this closure he picked up the denuded vesical neck with some of the interrupted stitches, thus, plicating it. He then used a single large reinforcing suture to bring the vaginal mucosa on either side of the incision together in the midline, to relieve tension from the plicating sutures. He states that he performed the first operation in 1911, and his report was published in the November, 1913, issue of *Surgery, Gynecology and Obstetrics*, the paper having been presented before the American Gynecological Society in May, 1913. Kelly published his description of the operation first in the *Urologic and Cutaneous Review* in June, 1913. In this article he states that he had been performing this operation for the past 10 or 12 years. It would thus appear that Kelly not only published his description first, but also performed the operation several years before Baldy.

The operation, as performed by Kelly, follows:



"H" is the head of the catheter marking the neck of the bladder. "GGGG" are the guy sutures holding the wound open. "S" is the suture at the neck of the bladder re-uniting the sphincter muscle.

FIG. 2.—Original Kelly diagram of vesical sphincter plication.

"With the patient in the lithotomy position, the posterior wall of the vagina is retracted and the area at the neck of the bladder is brought down with either forceps or guy sutures.

"The next step is to slit the vaginal wall down to the urethra and the bladder in the median line for about 1.5 or 2 inches. The neck of the bladder should fall at about the center of the incision. The position of the neck is easily determined at all times by moving the catheter to-and-fro, and feeling its head which presses close up against the urethra. The utmost care should be taken not to cut into the urethra or the bladder at any step of the operation. After making this median incision, the vagina is further dissected off on both sides with tissue forceps and dissected away for a distance of 2 to 2.5 cm. around the neck of the bladder. This dissection may be made with blunt pointed scissors which push their way into the tissues, separate the bladder from the vaginal walls and then cut the connecting fibers. The dissection should be deepest at the neck of the bladder.

"When the detachment of vagina from the bladder is completed, the finger should be able to grasp at least one-half or two-thirds of the neck of the bladder, including the contiguous urethra. Sometimes the bladder wall is so thin that its mucosa shines through.

"The next step is to suture together the torn or relaxed tissues at the neck of the bladder, using two or three mattress sutures of fine silk or linen passed from side-to-side. The first suture, taking in about 1.5 cm. of tissue, is tied at once when the succeeding suture may be passed outside of this, further contracting and bringing together the tissues at the neck. This is the principal part of the operation, and when done the mushroom catheter ought to be pulled out, the head of the catheter escaping with a little jump as it clears the tightened reconstructed sphincter at the neck of the bladder. The more or less redundant vaginal walls, which have been detached in order to expose the sphincter area, are now resected so that the remaining tissues can be snugly brought together from side-to-side, so as to support the vesical area operated upon and avoid any dead space between bladder and vagina." Kelly's rather crude original illustration is shown in Figure 2.

The operation which we perform today differs somewhat from Kelly's original procedure. It may be noted from Kelly's description that his plication was done only at the "neck of the bladder." He frequently superimposed two or three mattress sutures at that point, but he did not plicate the musculature for the length of the urethra. Our present procedure utilizes the musculature of the full length of the urethra as well as the internal sphincter region.

We are indebted to Kennedy for our knowledge of the sphincter action of the urethra. He studied the urethral mechanism with the aid of radiographs. The bladder was first filled with 200 cc. of a 3 per cent solution of sodium iodide. A thin rubber sac was then inserted into the urethra to distend and outline it. The sac was filled with 25 per cent solution of sodium iodide connected with a water manometer at 30 cm. of pressure. By taking roentgenograms when the patient was to "hold, relax and void" the action of the urethral sphincter was studied. By studying normal women and patients with various degrees of incontinence, Kennedy concluded that there is an involuntary sphincter about each of the inner and outer thirds of the urethra and an additional sphincter about the middle third of the urethra which is probably under voluntary control. This control, he found to be greater than either of the involuntary muscle controls. He found that if a pressure of 30 cm. of fluid stretched the sphincter about the middle third of the urethra, he was justified in suspecting some degree of incontinence. Kennedy also emphasized the importance of adhesions between the urethra and pubic rami. These adhesions he believed to be the result of trauma from the child's head or from previous surgery in the urethral region. Our clinical experience confirms both of Kennedy's conclusions. The presence of sphincters along the entire urethra is confirmed by inspecting the urethra along its entire course through the

URINARY INCONTINENCE IN WOMEN

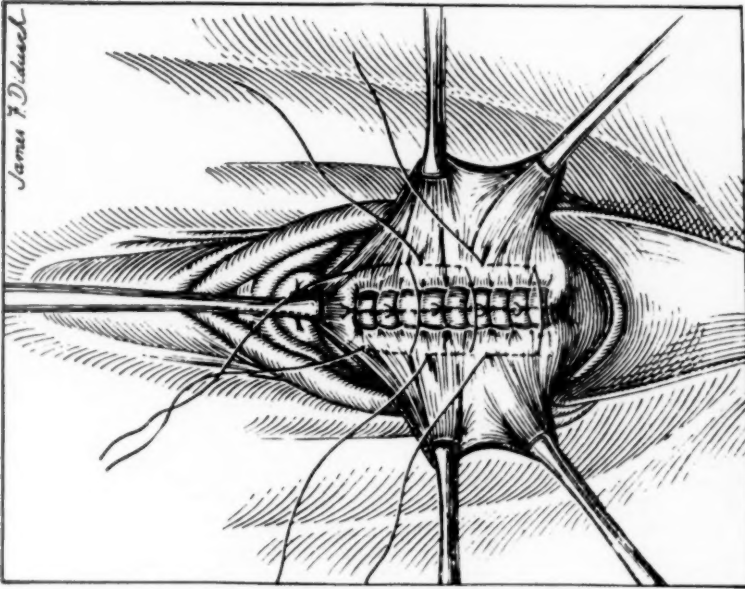


FIG. 3-B.—Second row of mattress sutures approximating the fascia beneath the urethra.

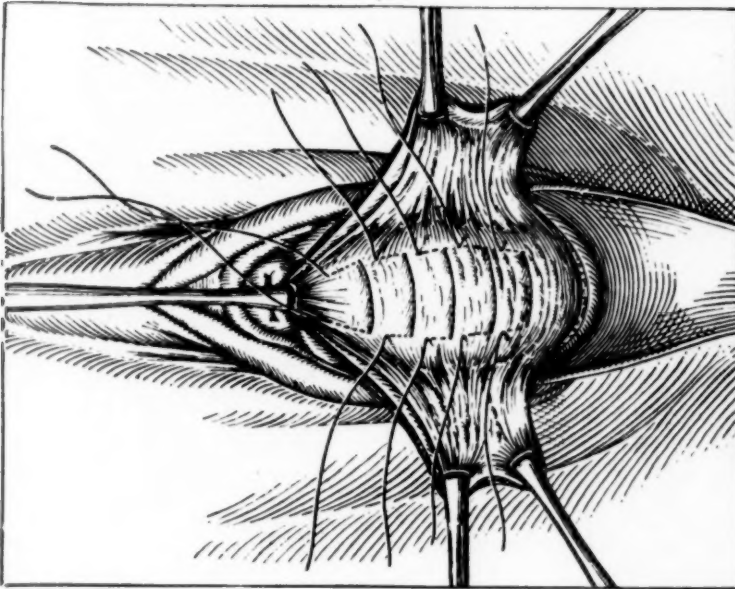


FIG. 3-A.—Mattress sutures which plicate sphincter fibres from trigone to near the end of the urethra.

Kelly air cystoscope. As one withdraws the cystoscope he can notice concentric contractions about the end of the instrument from the trigonal end of the urethra to the meatus. We have also, on occasion, seen evidence of the urethral sphincters being fixed at points by means of periurethral scar tissue. These adhesions have followed childbirth and operative procedures in the urethral regions. Fixed irregular apertures seen on withdrawal of the cystoscope and periurethral scar tissues encountered at operation confirm Kennedy's ideas. However, it is our belief that periurethral adhesions are less frequently a factor in incontinence than Kennedy believes them to be and on the basis of which he devised his operation for the cure of incontinence. We would, then, limit the use of the Kennedy operation to those cases in which periurethral adhesions have been proven by cystoscopic examination.

Kennedy's operation will be briefly described before discussing the one used in this clinic. A midline anterior vaginal incision from cervix to about 1.5 cm. from the urethral meatus is made and the vaginal walls separated from the bladder laterally as far as the rami. "By blunt dissection, the urethra is separated from the median posterior margin of the ramus (keeping extremely close to the ramus) and the separation carried into the paravesical space, which is about 6 cm. The same dissection is repeated on the opposite side, after which the urethra becomes entirely free laterally . . ." The urethral wall is then doubly plicated with mattress sutures for the length of the exposed urethra, which is all of it except the distal 1.5 cm. Finally, three silver wire sutures are placed through the mucosa of the vaginal vestibule close to the margin of the pubic rami. Kennedy believes that twisting together of these approximates the voluntary sphincter fibers.

The operation done by the author has some of the features of Kelly's original method and some of Kennedy's. If a cystocele is present, an incision is made through the anterior vaginal wall from the cervix to within a half centimeter of the urethral meatus. If there is no cystocele, the incision is carried only the length of the urethra and for about a centimeter beyond beneath the trigone. The vaginal mucosa is dissected laterally, stripping the fascia from it. This fascia is to be used for subsequent plication to form a floor on which the urethra and bladder base rest. If a cystocele is to be repaired, the usual advancement operation is done with plication of the pubovesicocervical fascia in the midline. If there is reason to believe from previous investigation that periurethral adhesions are responsible for the failure of the sphincter to close properly, the urethra is freed extensively laterally, as advised by Kennedy. Otherwise, no attempt at freeing the urethra is made except to expose its inferior surface. A series of mattress sutures of medium silk are taken, beginning about a centimeter beyond the vesical end of the urethra and extending to within a half centimeter of the meatus (Fig. 3, A). When the incontinence is marked, the internal sphincter

FIG. 4.—Miller modification of Goebell-Stoeckel operation. A. Fascial strip has been freed and is split. B. Showing method of encircling urethra.

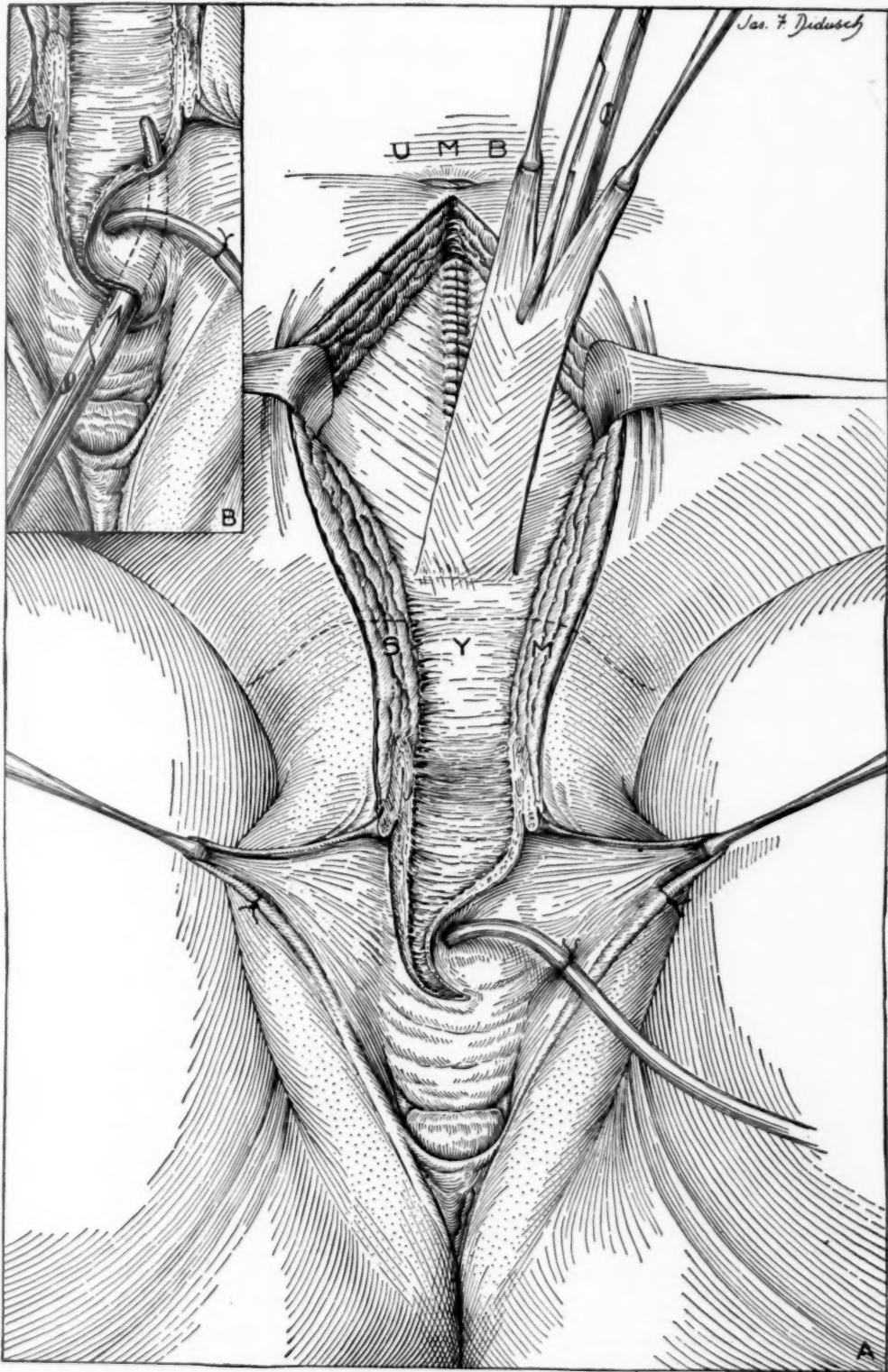


FIG. 4A and B

region can be more tightly plicated by taking two or three mattress sutures at that point, as suggested by Kelly, each succeeding suture burying the preceding one. The internal end of the urethra can be identified by the use of a mushroom catheter, but with experience this can be omitted. After the first row of sutures is tied, a second row is placed which invert the first row and approximate the fascia. This restores the floor upon which the urethra rests (Fig. 3, B). The excess of vaginal mucosa is excised and the mucous membrane closed with interrupted fine catgut sutures. We prefer not to use an indwelling catheter in order to avoid holding the urethra open. If the patient fails to void, repeated catheterization may be required. If only a simple plication operation is done we do not hesitate to permit the patient to get up to void immediately upon regaining consciousness. If the procedure has been done as part of an extensive vaginal plastic, she is kept in bed 12 to 14 days.

An operation of this type was done on the Gynecological Service of the Johns Hopkins Hospital 249 times during the past ten years. Of these patients, 90.3 per cent reported that they were well; 5 per cent were improved; 3.5 per cent were unimproved, and there was no data on 1.2 per cent. The failures rarely occurred in those cases in which a well-developed urethrocele or cysto-urethrocele was present. They occurred chiefly in those cases in which there was simple sphincter weakness without cystocele, and in cases in which there was a great excess of scar tissue about the urethra as the result of previous operations. The subsequent treatment of the failures will be considered later in this paper.

THE GOEBELL-FRANGENHEIM-STOECKEL TYPE OF OPERATION

From the above report it is obvious that we must search further for a cure of some cases of stress incontinence. After one or more unsuccessful plications, scar tissue may make further plication futile. Also, in those cases in which the urethra and sphincter mechanism have been destroyed, the reconstructed urethra has no contractile power, and this must be supplied from some other source. Finally, in certain neurologic bladders with incontinence, there is the possibility that a new sphincter mechanism can be supplied which will function sufficiently well to give the patient control.

For many years past, surgeons and urologists have attempted to supply sphincter action by transplanting muscle from without. Martius⁸ used the bulbocavernosus, Deming⁹ the gracilis, and others utilized part of the levator ani muscles. Although some successes have been reported, there were many failures and most of these operative attempts are only of historic interest. The operations of this type which are done today are chiefly modifications of the Goebell-Stoeckel technic, first described in 1910. In that year, Goebell¹⁰ reported on the transplantation of the pyramidalis muscles retropubically, encircling the posterior urethra. In 1914, Frangenheim¹¹ modified Goebell's technic by utilizing a strip of rectus fascia from the midline, to which the pyramidalis muscles were attached. Stoeckel¹² was the first to combine the Goebell-Frangenheim strap technic with a vaginal plastic procedure. Norman

Miller¹³ objected to bringing the strap of fascia down retropubically because of the possibility of hemorrhage and bladder injury in the inaccessible retro-pubic space and accordingly modified the Goebell-Stoeckel operation by bring-

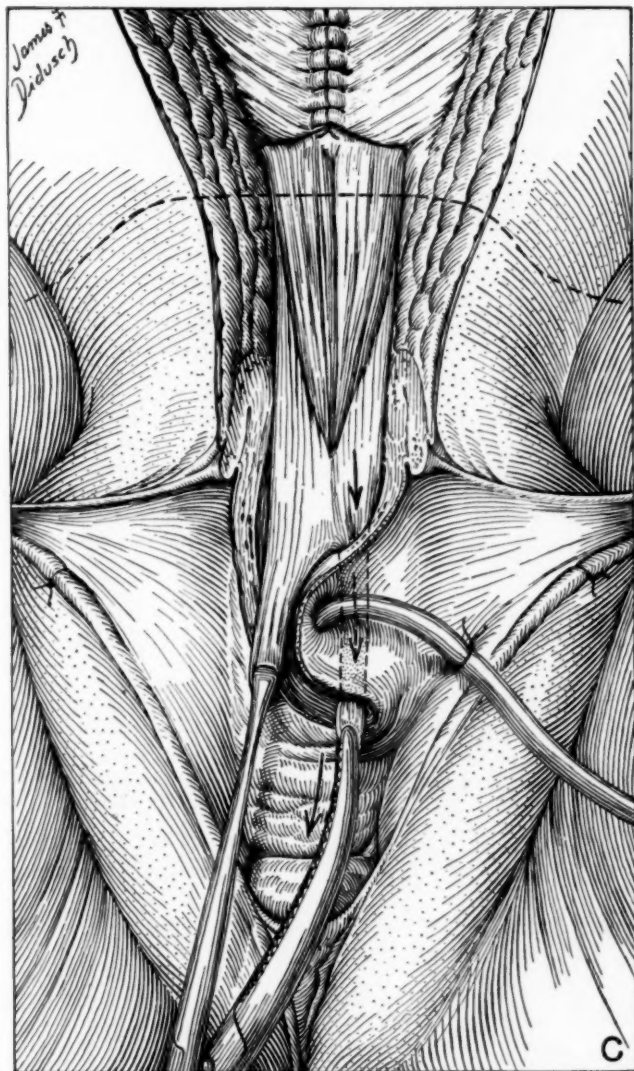


FIG. 4.—Miller modification of Goebell-Stoeckel operation.

C. Fascial strips have been brought down and will be sutured beneath the urethra.

ing the fascia down anterior to the symphysis (Fig. 4, A, B, C). The first operation of this type performed in our clinic was done according to Miller's modification and an excellent result was obtained, but we have abandoned this modification because one is able to get a more direct pull on the posterior

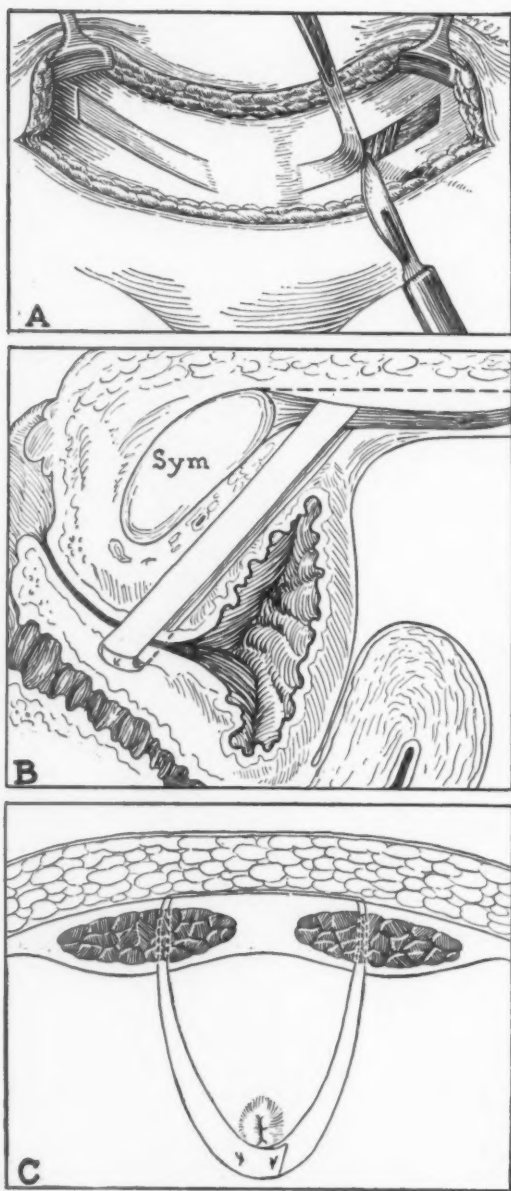


FIG. 5.—Aldridge modification of Goebell-Stoeckel operation for urinary incontinence.

A. Fascial strips are being separated through a Pfannenstiel incision.

B. Fascial strips shown in position around posterior portion of urethra. Dotted line indicates position of rectus muscles when contracted.

C. Diagram indicating slinglike action of the fascial strips.

urethra by the retropubic route. Nor have we injured the bladder or encountered hemorrhage by tunnelling retropubically. In 1942, Aldridge¹⁴ modified the procedure by making a transverse semicircular abdominal incision and cutting bilateral straps of fascia obliquely upward and outward. The straps which are left attached at the medial ends then are made to pierce the rectus muscles as they are brought down behind the symphysis (Fig. 5). There is one obvious advantage to the bilateral straps in those cases in which there is an old midline scar. Aldridge also believes that the spring obtained from the rectus muscles in their normal positions is far better than one could obtain from the displaced pyramidalis muscles.

We have performed operations of this general type 13 times in our clinic during the past ten years. Since 1942, we have generally used Aldridge's modification, which appears to have the advantages claimed for it by its author. Our series is small, which indicates that we have selected our cases with care. It is easy to become over-enthusiastic about this procedure but we have restrained ourselves when we believed a lesser operation would suffice. For example, if a woman who has had previous unsuccessful surgery for stress incontinence presents herself with a well-developed cysto-urethrocele, we do

not proceed with this operation. It is obvious that she has not had proper vaginal plastic work done, and we repeat it with urethral plication. If the Goebell-Stoeckel operation were done routinely for such cases, the percentage of cures would be in the neighborhood of 100 per cent. In all of the cases in our series in which the operation was done for stress incontinence following failures at plication, the operation was successful, with a single exception. This failure was apparently due to a great excess of scar tissue resulting from previous attempts at plication. On the other hand, more recently, a perfect result was obtained in a similar case, using the Aldridge modification. Sphincter function was given to two patients with spina bifida occulta and to one with a mild tabetic bladder. Neurologic bladders should be selected for this operation with the greatest of care. They should be subjected to cystometric examination before a decision to operate is made. Operations of the Goebell-Stoeckel type should be restricted to those cases in which there is a relaxation of the involuntary sphincter and an absence of voluntary sphincter control. The bladder should not be too spastic as the expulsive power of the spastic bladder would probably overcome the added resistance offered by the transplanted fascia.

The Goebell-Stoeckel type of operation failed to cure all three of our patients upon whom a plastic operation had been done previously to form a urethra. In one case the entire urethra had sloughed following a difficult delivery. In the second there was a congenital absence of urethra and seven previous attempts had been made to create a urethra and restore continence. In the third case the whole urethra and part of the bladder wall had been eaten away by lymphopathia venereum. Failure in these three instances can be attributed to several factors: The absence of *any* normal sphincter mechanism places more responsibility upon the strap for complete sphincter action. Apparently, the strap often fails in this. The urethra which is formed by the plastic procedures is usually too short to serve as an adequate tube against which the strap can make pressure. The artificial urethra is also usually too thin for surgical dissection without perforating into the lumen, and it contains so much scar tissue that postoperative sloughing may occur after attempting the strap operation. In the case of the healed lymphopathia the tissues were still the site of chronic edema and fibrosis, making surgical manipulation very difficult and healing uncertain because of lack of blood supply.

The modified Goebell-Stoeckel operation as done in our clinic follows:

The position of the patient on the table is important. She is placed in a modified lithotomy position with the thighs not too acutely flexed on the abdomen. In this position the abdominal wall may be exposed and the patient will not require redraping for the vaginal work. A complete clean-up of the abdomen and vagina is done before draping. The perineum is temporarily covered by a sterile towel which is removed at the beginning of the vaginal part of the operation. Likewise, the abdominal wound is closed after the fascial straps are cut, except for a small segment in the midline, and the

wound covered with a sterile towel held in position by towel clips to prevent contamination while the vaginal operation is being done.

A semicircular transverse lower abdominal incision is made through the panniculus; the aponeurosis is cleared of fat over an area about one inch wide and bleeding is controlled.

The strips of fascia are cut on either side of sufficient length to be carried down retropubically and encircle the urethra. The length of these strips, naturally, must be estimated and will vary, depending upon the width of the symphysis pubis, but if they are carried up to the level of the anterior superior spines of the ilia they will be of sufficient length, even though the symphysis is quite wide. The strips will be composed of the aponeuroses of both external and internal oblique. They are separated from the subjacent muscle and, thus, mobilized down to their bases. The medial end of each strip is left attached at about 1.5 cm. from the midline. The incisions in the aponeuroses are then closed with continuous sutures of No. 1 chromic catgut, the fat approximated with interrupted sutures of double zero chromic catgut and the skin closed with continuous fine silk, leaving a small unclosed space at the lower portion of the incision. The fascia strips are placed in this space and covered with moist sponges. The closed portion of the abdominal wound is covered with sterile towels.

The operator is then seated for the vaginal portion of the operation. The labia minora are sutured laterally for good exposure and a posterior retractor placed in the vagina. An Allis clip is placed in the urethral meatus and a second one in the midline on the vaginal wall about six centimeters back from the first. A midline incision is then made through the vaginal mucosa, extending from about 1 cm. from the urethral meatus back for about 5 cm. The vaginal mucosa is dissected laterally and the fascia stripped from it. If the operator intends to combine the Goebell-Frangenheim-Stoeckel procedure with urethral plication, this is done as previously described.

No attempt is made to dissect digitally lateral to the urethra, as suggested by Aldridge and Studdiford.¹⁵ The author does not believe that this is necessary and bleeding may be avoided by omitting it. However, the index finger of the left hand is placed at the left side of the urethra. Then, using a long Kelly clamp in the right hand, the space of Retzius is entered from above by penetrating the rectus muscle at the base of the fascial strip. The point of the clamp is directed downward and against the periosteum of the symphysis. By taking this precaution the author has never perforated the bladder or had any persistent hemorrhage. In most cases, the bleeding is *nil*. The Kelly clamp is then forced down lateral to the urethra, aiming at the tip of the left finger below. In some instances, the fascia at this point is so tough that it is perforated with difficulty by the blunt Kelly clamp but a small cut with the scalpel directly over the point of the clamp permits it to perforate. Then the clamp is opened slightly and a second clamp, similarly opened, is fed into the jaws from below. Both clamps are shut and traction made on the upper clamp as the lower clamp is pushed. Then the end of the left fascia strip is fed into the

jaws of the lower clamp and the clamp withdrawn from below. This is repeated on the opposite side, and, thus, the ends of both strips are delivered beneath the urethra. The straps are over-lapped slightly, any excess is cut off, and the strips sutured together with three or four interrupted sutures of medium silk. Care is taken to get the proper amount of tension on the straps to give the patient continence. This is tested by distending the bladder through a glass catheter and making moderate suprapubic pressure. The excess of mucosa is excised and the vaginal wound closed with interrupted sutures of No. 0 catgut. The small midportion of the abdominal wound is then closed. We prefer not to use an indwelling catheter, but if the patient fails to void spontaneously within several days, we occasionally resort to it.

VESICOVAGINAL FISTULA

The subject of vesicovaginal fistula dates from antiquity. Since the literature contains many historical sketches of the subject, no attempt at such a review will be made here, but reference will be made to a few of the milestones in the development of our present operative knowledge. No one man is responsible for this knowledge, it having been acquired step-by-step through the tireless efforts of surgeons dating back to the 17th century. Before that time the condition was considered hopeless and one sees references even as late as the middle of the 18th century to the treatment of these fistulae by the wearing of a pulverized toad in a little bag over the pit of the stomach. The more practical-minded of these times devoted their efforts to making receptacles to catch the urine, and, thus, make the life of the victim more endurable.

The first real surgical contribution was made by a Hollander, H. Van Roonhuyse,¹⁶ whose contributions were far in advance of his time and apparently overlooked by many later writers who fumbled about with much less rational methods. In 1672 Van Roonhuyse recommended:

The placing of the patient in a position appropriate for lithotomy.

The satisfactory exposure of the fistula by a retracting speculum.

The thorough denudation of the margins of the fistula.

The approximation of the denuded edges by means of quills thrust through the edges of the wound and held in place by silk threads.

The dressing of the wound with balsam and absorbent vaginal dressings.

The patient kept quiet in bed until the parts had healed.

There is no report of Van Roonhuyse's successes and failures but Johannas Fatio¹⁷ of Basel reported on two cases successfully operated upon by him in 1675 and 1684. He states that he employed the "method of the skilled physician, Van Roonhuyse."

Little progress was made after that until 1839, when George Hayward,¹⁸ at the Massachusetts General Hospital, reported nine cases in which he described the important technical point of detaching the vagina from the bladder. Then came ether anesthesia, and it was probably used for the first time for this operation by Hayward, in 1847. In 1846, Metzger,¹⁹ of Prague, described using an instrument very much like the Sim's speculum. In 1847,

John Mettauer,²⁰ of Virginia, first used twisted metal (lead) sutures. In 1852, Wutzer,²¹ of Bonn, reported curing 11 out of 35 patients. He first used suprapubic drainage.

In 1845, Jobert de Lamballe²² described his incision for relieving tension on the fistula suture line. It consisted of a transverse vaginal incision anterior to the cervix, whereby the bladder could be freed from the cervix. Gustav Simon,²³ who was a pupil of Jobert, and appreciated the value of easing the tension on the suture line, attempted to do this by the use of tension sutures instead of incisions.

Marion Sims²⁴ first paper on vesicovaginal fistula appeared in 1852, and it is generally conceded that he is the father of surgery for vesicovaginal fistula in America. There is no doubt that he attained greater success than anyone up to his time. It is interesting to note, however, that his operation was not new. Each step had been used and described before by the surgeons mentioned above, and others. The only innovation which Sims contributed was the use of silver wire. This was, in truth, one of the greatest contributions and Sims guarded his priority with such jealousy that he devoted most of his anniversary oration before the New York Academy of Medicine, in 1857, to defending it. He declared it to be "the most important contribution as yet made to the surgery of the present century.

"The only thing comparable to it is etherization, and in practical results of permanent benefit, it is absolutely contemptible, when compared with those from the universal use of silver sutures in the broad domain of general surgery."

Since the time of Sims there have been changes and refinements in technic but nothing revolutionary. These points will be discussed in considering the principles which we have used in operating upon these reported cases. The present series consists of 41 patients with vesicovaginal fistula upon whom we have operated during the past ten years.

Causes and Prevention.—Much can be learned about the prevention of vesicovaginal fistulae by a study of the causes. We have listed the causes in Table I:

TABLE I
41 CASES OF VESICOVAGINAL FISTULA

| Causes | Number of Cases |
|---|-----------------|
| Vaginal delivery..... | 8 |
| Rupture of uterus, bladder and vagina following pituitrin during labor..... | 1 |
| Total abdominal hysterectomy..... | 15 |
| Subtotal abdominal hysterectomy..... | 2 |
| Radium treatment for carcinoma of cervix..... | 3 |
| Radium treatment for benign bleeding..... | 1 |
| Radium and total hysterectomy for carcinoma of cervix..... | 3 |
| Manchester operation..... | 1 |
| Colpotomy..... | 1 |
| Cesarean section..... | 1 |
| Vaginal removal of cervical stump..... | 3 |
| Automobile accident..... | 1 |
| Biopsy bladder tumor..... | 1 |
| Total..... | 41 |

The striking thing noted is the low incidence of fistulae due to vaginal deliveries and the high incidence due to total abdominal hysterectomy. Fifty years ago obstetrical injuries were responsible for more fistulae than all other causes combined. Due to the improvement in obstetrics the incidence of fistulae due to deliveries has been reduced to a minimum. (Eight out of our 41 cases). On the other hand, within the past decade there has been a tremendous increase in fistulae resulting from total abdominal hysterectomies. (15 of our 41 cases). This is the result of a great swing toward total hysterectomy on the part of American operators. Many publications from the larger gynecologic clinics have advocated routine removal of the cervix whenever the uterus is removed. As a result of this many surgeons have adopted this practice who lack the experience or surgical skill to do the operation expertly. From this source come most of the vesical fistulae seen today. It is not the purpose of this paper to discuss the relative merits of total and subtotal hysterectomy, but it behooves every inexperienced surgeon to take council with his conscience before performing the total operation in cases where the lesser procedure will cure the patient. It is true that vesicovaginal fistula does occasionally occur as a sequel of a very difficult subtotal hysterectomy, as is shown in this series, but bladder damage in the run-of-the-mine subtotal hysterectomy is inexcusable.

The five cases in the series in which vesicovaginal fistula followed irradiation for cervical cancer does not represent the total number of fistulae occurring in our Radium Clinic but only those cases in which repair was attempted. In two cases irradiation and total hysterectomy preceded the fistula. In one of these the cause was obviously irradiation, for the fistula appeared 11 years after the surgery and irradiation. In the other it was impossible to be certain which of the two factors was responsible for the fistula.

The three cases of fistula following vaginal removal of the cervical stump are worthy of note. One of these cervixes was removed by electrosurgical means and the others by scalpel. It is our belief that, generally, it is a safer procedure to remove a cervical stump transabdominally, if a complete removal is desired. If a partial removal is all that is required, it can safely be removed *per vaginam* with the electrosurgical instrument. As a result of peritonealizing the cervical stump at the time of the subtotal hysterectomy, the bladder is often intimately bound to it, so the more or less blind dissection from below is hazardous to the bladder.

RESULTS: Of the 41 patients with vesicovaginal fistula, excluding those with complete destruction of the urethra, 37 were cured. The results are shown in Table II.

In two of the successful cases, three operative attempts were made in our clinic before the fistula was finally closed; in seven cases two attempts were necessary and in the rest the closures were successful as a result of our first attempt. Only 15 of the 41 patients came to us for the first attempt at closure. Eleven had had one previous attempt; eight had had two previous attempts;

four had had three attempts; and three had been operated upon unsuccessfully seven times before coming to our clinic.

TABLE II
RESULTS OF SURGERY ON 41 CASES OF VESICOVAGINAL FISTULA

| | Name | Previous Attempts | Operations on Our Service | Result |
|----|-------|--|--|---------|
| 1 | M.T. | None..... | 1 vaginal | Well |
| 2 | J.F. | 2. 1 "shortly" after delivery; 1 a year before admission..... | 1 vaginal | Well |
| 3 | B.V. | 1. 3 months after occurrence..... | 3. 1st—abdominal 2nd—vaginal 3rd—vaginal | Well |
| 4 | A.F. | 2. 1 two weeks after occurrence and another 6 years later.... | 1 vaginal | Well |
| 5 | E.R. | None..... | 2. complete closure of vagina | Well |
| 6 | F.L. | 1. 5 months after occurrence..... | 1 vaginal | Well |
| 7 | L.J. | 1. 6 weeks after occurrence..... | 3 vaginal | Well |
| 8 | H.E. | 2. | 2. 1st—abdominal 2nd—vaginal | Well |
| 9 | M.F. | 1. 5 months after occurrence..... | 1 vaginal | Well |
| 10 | H.M. | None..... | 1 vaginal | Failure |
| 11 | E.R. | None..... | 1 vaginal | Well |
| 12 | O.D. | 3. at monthly intervals beginning 1 month after occurrence | 2 vaginal | Well |
| 13 | F.R. | None..... | 1 vaginal | Well |
| 14 | D.G. | 1. 7 months after occurrence..... | 2 vaginal | Failure |
| 15 | M.H. | 1. 4 months after occurrence..... | 1 vaginal | Well |
| 16 | G.H. | None..... | 1 vaginal | Well |
| 17 | D.H. | 2. 6 years before admission, vaginal and abdominal..... | 1 abdominal | Well |
| 18 | E.T. | 7. 4 abdominal and 3 vaginal over 4 years..... | 1 vaginal | Well |
| 19 | J.Mc. | None..... | 1 vaginal | Well |
| 20 | G.S. | 1. 2 months after occurrence..... | 1 vaginal | Well |
| 21 | D.H. | 1. 2 months after occurrence..... | 1 vaginal | Well |
| 22 | B.H. | None..... | 1 vaginal | Well |
| 23 | D.T. | 3. 1 month; 3 months; 16 months after occurrence..... | 1 vaginal | Well |
| 24 | E.S. | None..... | 2 vaginal | Well |
| 25 | E.B. | 2. 1 vaginal 5 months after occurrence and intra-abdominal 1 month later | 1 vaginal | Well |
| 26 | R.C. | 7. Between 1938 and 1943..... | 1 vaginal | Well |
| 27 | E.D. | 1. Abdominal..... | 1 vaginal | Well |
| 28 | R.P. | None..... | 1 vaginal | Failure |
| 29 | Y.B. | 1. 2 years after occurrence..... | 1 vaginal | Well |
| 30 | K.N. | 7. 1st 2 months after occurrence; next 3 attempts in 3 months | 1 vaginal | Well |
| 31 | E.R. | 2. | 1 vaginal | Well |
| 32 | M.H. | 3. | 2. 1st—abdominal 2nd—vaginal | Well |
| 33 | N.J. | None..... | 2 vaginal | Failure |
| 34 | E.C. | None..... | 1 vaginal | Well |
| 35 | P.L. | None..... | 1 vaginal | Well |
| 36 | A.W. | 1. vaginal 5 months after occurrence..... | 1 vaginal | Well |
| 37 | R.N. | 2. 1st 1 year after occurrence; 2nd 2 weeks later..... | 1 vaginal | Well |
| 38 | N.J. | 3. 1 abdominal, 9 days after delivery; 2 vaginal..... | 1 vaginal | Well |
| 39 | K.D. | None..... | 1 vaginal | Well |
| 40 | R.G. | 2. 1st 5 months after occurrence; 2nd shortly after..... | 1 vaginal | Well |
| 41 | E.K. | None..... | 1 vaginal | Well |

PRINCIPLES OF VESICOVAGINAL FISTULA SURGERY

There is no field in surgery in which the operator is thrown more completely on his own resources than when he is dealing with a vesicovaginal fistula. Each case is a problem unto itself, and often the operator must impro-

vise rather than carry out his previously carefully planned operation. Hence, in this paper no attempt will be made to describe typical operations but principles will be discussed which we feel have contributed to the success of this series of difficult operations. Even though some of these principles are old they will bear repetition, for it is obvious from the number of failures to cure vesicovaginal fistulae that they are often not applied.

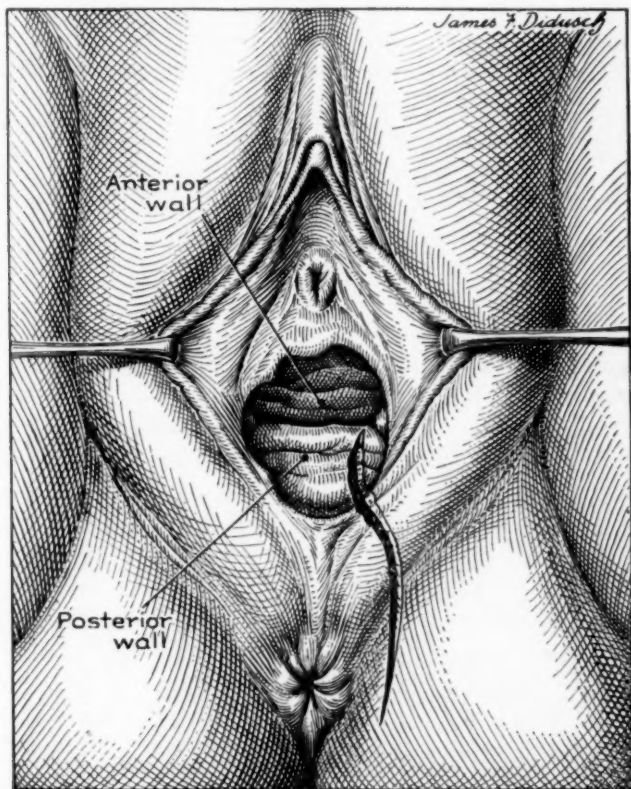


FIG. 6.—Schuchardt incision.

The advantage of having the tissues in the best possible condition before attempting closure is great. After the occurrence of a fistula, five or six months should elapse before surgery is attempted. Hunner has emphasized this repeatedly but a glance at Table II will show that many operators do not observe this rule. After this first failure, the surgeon often makes another attempt, sometimes within a few weeks. Possibly a sense of guilt in having had a hand in forming the fistula urges him to try again and again before the edema and infection of the previous operation have subsided. Each failure increases the amount of scar tissue and decreases the patient's chances of an ultimate cure. The situation should be explained to her, and in most instances

she will gladly wait to better her chances of ultimate cure. While the patient is awaiting surgery, she should be instructed to take sitz baths and to irrigate the vagina with potassium permanganate solution (1-8,000) or with a weak vinegar solution. This prevents and dissolves urinary salt incrustations and, in general, improves the condition of the tissues.

The approach to the operative field should be given considerable thought. More and more we favor the vaginal approach. In this series the abdominal approach was used only five times, and it should be noted that only one of these was successful. In the other four cases the fistulae were cured by a second vaginal operation. Almost never is an obstetrical fistula approached to advantage by the abdominal route. Formerly, we occasionally attacked a high postoperative fistula through the abdomen but by using the Latzko vaginal method we believe it will rarely be necessary in the future. About the only time it will be necessary to resort to the abdominal route will be in those cases in which the high fistula is inaccessible vaginally because of previous operations making the vagina narrow and rigid. Before giving up the vaginal approach, one should always remember that a deep vagina can be made relatively shallow by the Schuchardt incision (Fig. 6). Most of our vaginal operations are done with the patient in the lithotomy position but occasionally we use the Sims' left lateral or the knee-chest position.

Special attention should be directed to the Latzko method of closure of high vesicovaginal fistulae. It is particularly important for surgeons to recognize and use this procedure because it is so well adapted to the everincreasing number of fistulae following total hysterectomy. In 1933,²⁵ Latzko described partial colpocleisis for fistulae following panhysterectomy. The method is illustrated in Figure 7. The procedure is usually relatively simple to execute and we have had no failures in closing these postoperative fistulae since we have used it. Inasmuch as these fistulae are at the apex of the vagina, the amount of vaginal shortening is negligible, unless the fistula has been greatly increased in size by previous unsuccessful operations. In one of the above cases in which there had been seven previous attempts at closure, it was necessary to close the upper two-thirds of the vagina. Although this is undesirable, the inconvenience is nothing compared to that of the preëxisting incontinence. I am convinced that this particular fistula could not have been closed by any other method.

Although the *sine qua non* for the use of the Latzko technic has always been that the patient's uterus be previously removed, we have recently found

FIG. 7.—Typical Latzko operation for closure of post-panhysterectomy vesicovaginal fistula.

- A. Line of incision.
- B. Denudation of vaginal mucosa.
- C. Anterior and posterior vaginal mucosa has been removed.
- D. First layer of interrupted mattress sutures.
- E. Second layer of sutures.
- F. Closure of vaginal mucosa with silver wire sutures.
- G. Completed operation.

URINARY INCONTINENCE IN WOMEN

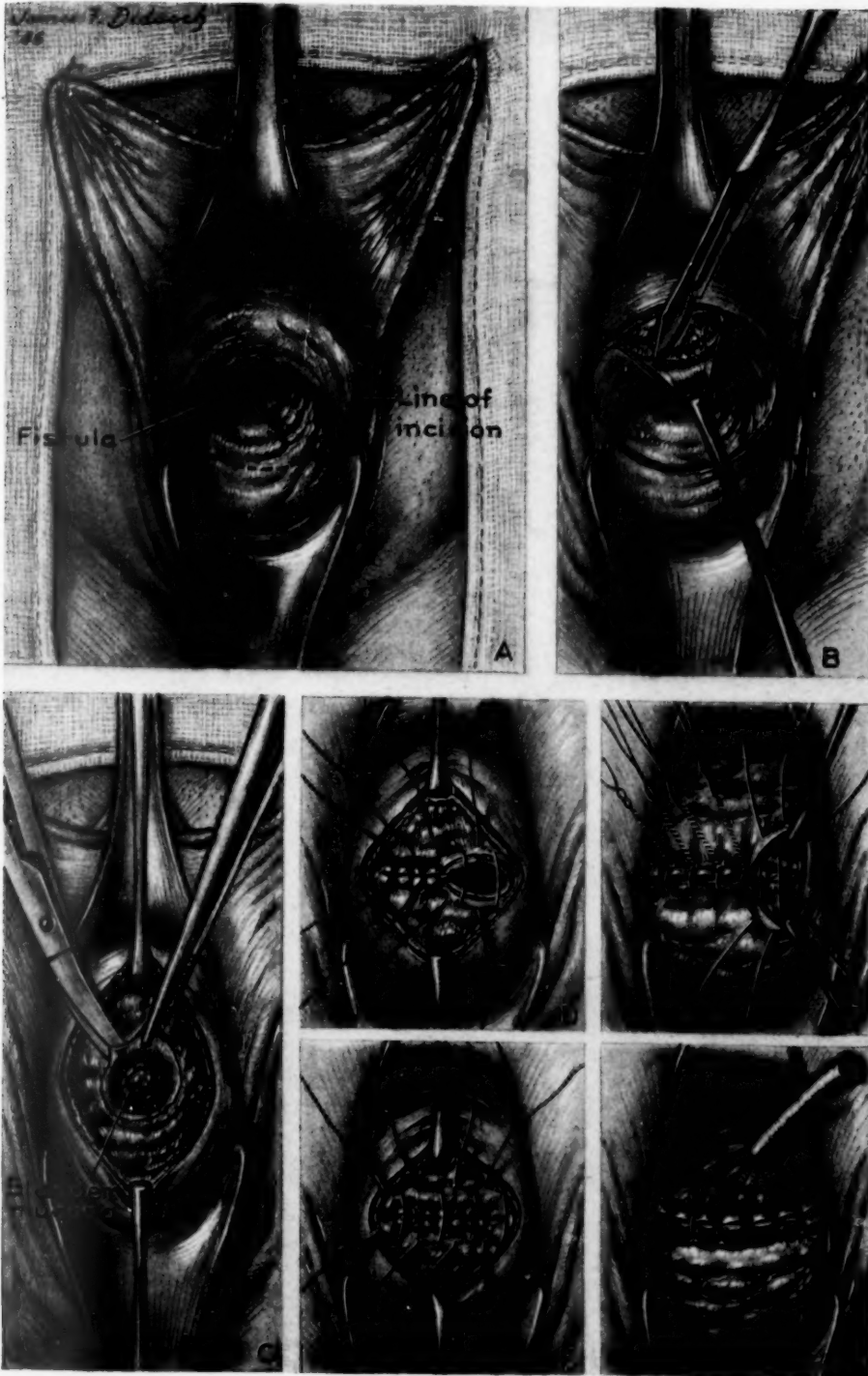


FIG. 7
83

an extension of its use, which is illustrated in three cases in this series. In these three cases the patients had been treated by irradiation for cervical cancer several years before. The cancer had been completely cured and the cervix totally eradicated by the radium, but the patients were left with large vesicovaginal fistulae. The extreme scarring so fixed the tissues that the condition would have been quite inoperable by any other technic. Denuding the vaginal mucosa both anteriorly and posteriorly and approximating the

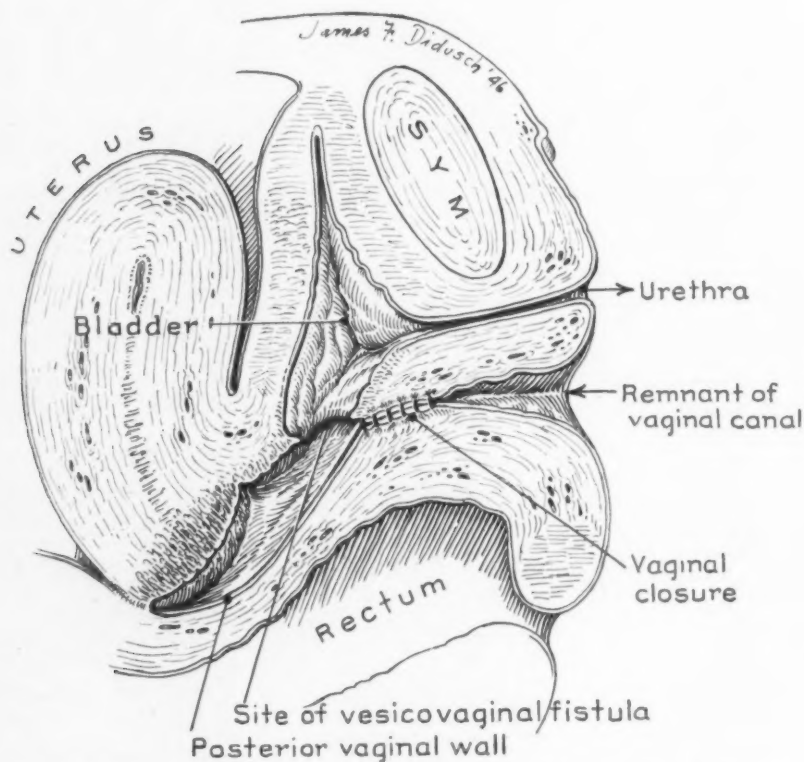


FIG. 8.—Demonstrating use of Latzko principle of partial colpocleisis for cure of vesicovaginal fistula in the presence of a cured cervical cancer.

vaginal walls over a broad area cured two of the three cases (Fig. 8). Including the obliterated cervix in the bladder apparently is quite innocuous. The third patient still has slight leakage. Although this procedure is applicable in only a small percentage of irradiation fistulae, it can give relief to a selected few women.

Before leaving the subject of the approach to the operative field, I should like to say that I have never seen a vesicovaginal fistula which seemed to be best approached transvesically, as practiced by some urologists. It is difficult for us to conceive of a case in which this would be advantageous.

URINARY INCONTINENCE IN WOMEN

In general, we prefer to close fistulae vaginally with the split-flap technic and approximate broad surface to broad surface. After dissecting the vaginal mucosa free, for about two centimeters around the circumference of the fistula, the edge of the bladder opening is inverted into the bladder, using a running Cushing stitch or an interrupted stitch of the same type (Fig. 9 B). In the more difficult cases the interrupted stitch is usually advantageous. Fine catgut should be used for this and, in tying, the tissues should be approximated but not strangulated. After the first suture line is placed, the bladder

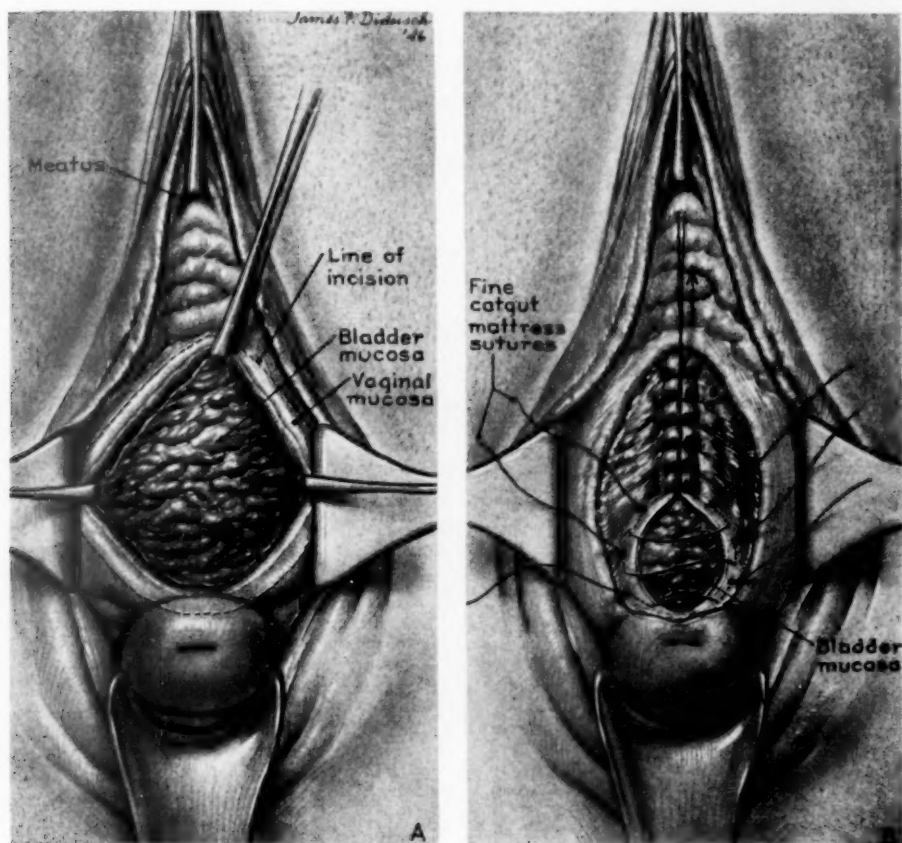


FIG. 9.—Closure of large vesicovaginal fistula.

- A. Showing defect and line of incision.
- B. Showing method of placing first layer of interrupted catgut sutures, inverting edge into bladder.

closure is tested. For this we use a weak solution of sterilized milk. This was first demonstrated to me by Guy Hunner. It is far superior to methylene blue solution because, if there is very slight leakage, a drop of the milk stands out very plainly against the bloody background. In addition, the milk does not stain the tissue, as does methylene blue solution. This is a distinct advantage if there is much leakage and if one is working at some depth where illumina-

tion is difficult. If leakage is demonstrated, further closure is done. If there is no excessive tension, a second line of sutures may be used to approximate the raw surfaces. However, if a second suture line has a tendency to result in too much tension, it is best omitted. The ragged avascular and scarred vaginal mucosa is then trimmed in order to be sure of good blood supply for healing. In the simple cases fine catgut may be safely used for suturing the



FIG. 9.—Closure of large vesicovaginal fistula.

C. Closure of vaginal mucosa with interrupted mattress sutures of silver wires everting mucosa. Note that sutures pick up subadjacent tissues to close dead space.

drainage. Occasionally, we close a simple fistula and permit the patient to get up to void immediately after recovering from the anesthetic. If she is unable to void, we prefer an indwelling catheter to repeated catheterization. In the difficult cases we believe bed rest up to two weeks is advisable and during this time foolproof drainage is essential. To provide this we frequently provide double drainage in the form of a therapeutic vesicovaginal fistula or suprapubic

vaginal mucosa, but in the difficult cases where there is excessive scar tissue from previous operations and, perhaps, a little more tension than desirable, there is no suture material equal to No. 26 silver wire. It can be left in place for two weeks or longer as its resistance to infection in this unclean field is truly remarkable. Although I cannot go quite as far as its discoverer (J. Marion Sims) and claim it as a greater discovery than etherization, I have great enthusiasm for its use in difficult fistulae. I prefer to place it as a mattress suture, everting the mucosal edge and approximating broad undersurface of the mucosa to broad surface. When these sutures are placed, I also like to pick up a bit of the subadjacent tissue to obliterate dead space (Fig. 9C). When conditions are such that a double-layer closure is impossible, silver wire is admirably suited for approximating the tissues in a through-and-through manner. In such cases tension can often be released by making a properly placed relaxing incision through the mucous membrane.

Many a perfectly executed operative closure is ruined by improper postoperative care. The essential point in postoperative care is bladder

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drainage in addition to the indwelling urethral catheter. Then, if one route becomes stopped, the other will provide drainage. If there is ample space above the level of the trigone, we prefer vaginal cystotomy. A mushroom catheter is inserted through a short midline vaginal incision and sutured in place with a heavy silk suture (Fig. 10). In the more difficult cases in which previous attempts have been made the anterior vaginal wall may be so scarred

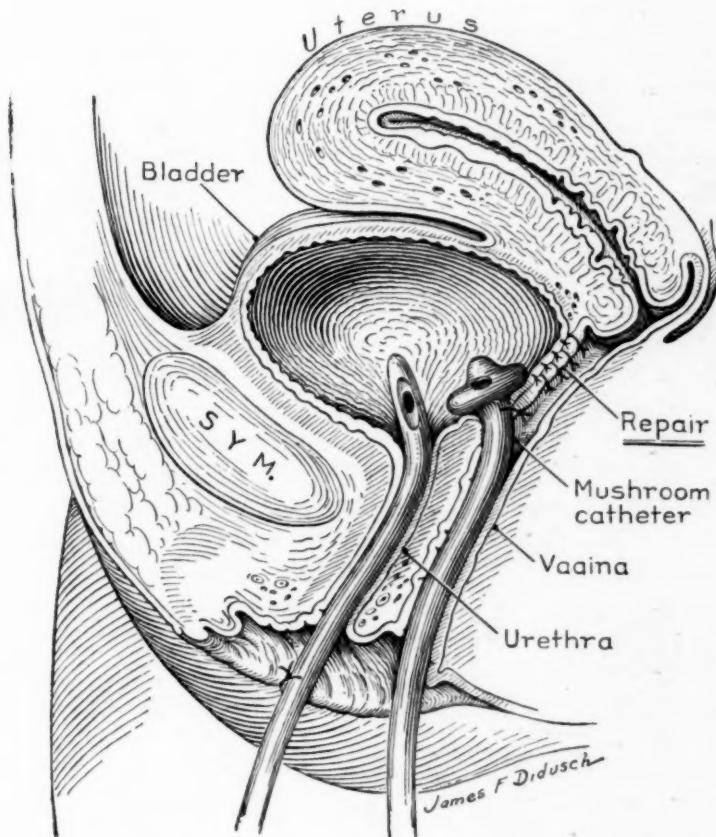


FIG. 10.—Double bladder drainage through urethra and vaginal cystotomy.

that a cystotomy is inadvisable. In such cases we resort to a suprapubic drainage tube, also in the form of a mushroom catheter (Fig. 11). The vaginal cystotomy closes spontaneously in a remarkably short time after withdrawal of the catheter two weeks later, if the incision has not been made through scar tissue. The suprapubic drainage tract also heals spontaneously within a few days. The patency of the catheters is tested by injecting a few cubic centimeters of normal salt solution daily. With the precaution of double drainage we have never felt it necessary to torture the patient by forcing her to lie in the prone position.

By the application of these principles we have cured 90 per cent of this series of fistulae, many of which had had repeated unsuccessful attempts at closure.

CONSTRUCTION OF THE DESTROYED OR CONGENITALLY ABSENT URETHRA

Among the most difficult cases of incontinence to cure surgically are those resulting from complete destruction or congenital absence of the urethra,

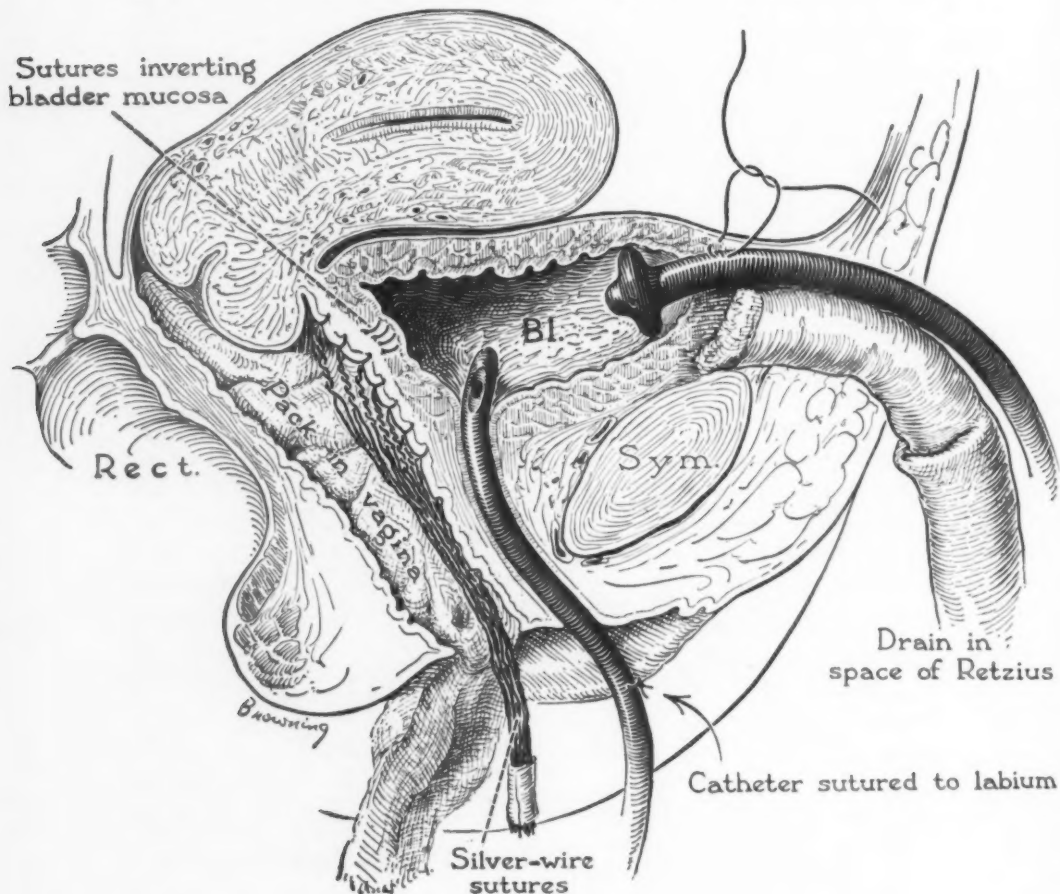


FIG. 11.—Double bladder drainage through urethra and suprapubic cystotomy.

including the region of the internal sphincter. Occasionally, one encounters such a condition as a result of childbirth injury and we have even seen one case in which the entire urethra was cut away by an operator in attempting to repair a cystocele. However, the majority of such cases seen in our clinic are the result of destruction of the urethra by lymphopathia venereum. Such lesions, at times, heal spontaneously, leaving the patient without a urethra but the tissues are left in a state of chronic edema and fibrosis. The tissues are

difficult to work on surgically, which adds to the already difficult task of performing plastic surgery in a field in which a certain amount of infection is inevitable.

Many operations have been devised for the formation of a urethra and the existing conditions in the urethral region suggest the best procedure to the operator. Regardless of his choice, failures in restoring continence will be frequent, for even though a perfect mucosal tube is formed, the sphincter is often still deficient.

The operation described here was conceived more or less independently by Drs. E. H. Richardson, Houston Everett, and the author, and we have used it with some success, but also with some failures. It is well suited to a case such as is illustrated in Figure 12.

A U-shaped flap of vaginal mucosa is dissected free, as shown in Figure 12 A, B. When held forward, the under surface of the trigone and sphincter region of the bladder is exposed. The sphincter is tightened by using a few interrupted sutures of medium silk (Fig. 12 B). In Figure 12 C, these silk sutures have been tied and the tissue inverted. The flap of mucosa is drawn downward and an area about 6 or 7 mm. in width is denuded forward on either side for a distance equal to the length of the flap (Fig. 12 D).

The edge of the flap is held forward with a smooth dissecting forceps and curled under, so that the raw surface of the flap may be sutured to the anterior denuded area (Fig. 12 E). Interrupted sutures of No. 00 chromic catgut are used. This is repeated on the other side, thus, forming an epithelial-lined tube to serve as a urethra.

The wound is closed by approximating the mucosal edges with interrupted sutures of No. 0 chromic catgut (Fig. 12 F). This buries the newly constructed urethra and closes the wound. The bladder is kept empty by means of a catheter in a surgically made vesicovaginal fistula, placed posterior to the newly made urethra.

URETEROVAGINAL FISTULA

Incontinence of urine due to ureterovaginal fistula usually results from operative injury to the ureter. When the ureter is transected but not ligated and the injury unrecognized at the operating table, urine may appear in the vagina almost immediately following the operation. More often the lower ureter sloughs as a result of accidental crushing or interference with its blood supply as in a Wertheim operation for cervical cancer. Then urine appears in the vagina several days after the hysterectomy. The question immediately arises as to whether one is dealing with a vesicovaginal or ureterovaginal fistula. The answer is easily obtained by filling the bladder with methylene blue solution. If the vaginal urine is unstained it is obvious that it is the ureter which communicates with the vagina. Cystoscopic observation of the ureteral orifices will readily prove which ureter has been injured. A ureteral catheter passed up the nonspurting ureter will meet an obstruction, indicating the site of the injury.

One next proceeds to determine the function of each kidney. A differential phthalein test is done by collecting from the uninjured side transvesically through a urethral catheter and collecting from the injured side in a bed pan. Intravenous urograms should be made on discovery of the fistula to determine the status of the upper segment of the injured ureter, the kidney pelvis and calices. Sooner or later these structures will show dilatation as scar tissue contracts about the injury in the ureter and if the condition is neglected kidney function will suffer.

A cure of the incontinence can be effected by nephrectomy, but nephrectomy is an admission of defeat and one's plan should be to save the kidney by performing an anastomosis between the segments of the ureter or the upper segment of the ureter and the bladder. Choosing the optimum time for this surgery is a matter of the keenest surgical judgment. If the operation is undertaken too soon, the pelvic tissues in the region of the ureter will be edematous, and the delicate surgery will be extremely difficult. If, on the other hand, one waits too long the function of the kidney will be reduced or even completely destroyed. The urge to operate within a week or two after the original operation is often irresistible to the surgeon who is responsible for the fistula, but failure is the usual outcome of such early attempts. It is desirable to allow as much as six weeks to elapse before undertaking the anastomosis. However, circumstances sometimes force the surgeon to operate before this time. As one awaits the passage of the six weeks, scar tissue forms about the injured ureter and its contraction may interfere with drainage, resulting in back pressure on the ureter, kidney, pelvis and calices. Slowly, but surely, this will destroy the kidney function. The sudden cessation of vaginal drainage usually is an indication for not too much delay in the contemplated anastomosis. The effect on the kidney should be watched by taking intravenous urograms at frequent intervals. Pyelitis may occur as a result of faulty drainage. This may be an indication for immediate surgery, but if it occurs shortly after the original operation, a temporary nephrostomy may be advisable which is permitted to function while one is waiting for the tissues in the operative field to get into condition for further surgery. If operation upon the ureter must be undertaken in the presence of infected urine, postoperative medication with sulfonamides and penicillin should be carried out.

Upon undertaking the anastomosis one must decide at the operation whether uretero-ureteral or ureterovesical anastomosis is the procedure of choice. In general, ureterovesical anastomosis is an easier procedure, and the chances of success are greater, but the high position of the injury may make it impossible to draw the ureter down to the bladder without excessive ten-

FIG. 12.—A. A "U"-shaped incision is made through the vaginal mucosa.

B. Mucosal flap has been freed and pulled forward. Three interrupted sutures of medium silk are placed to tighten sphincter region.

C. Sphincter sutures have been tied, inverting tissue.

D. Mucosal flap has been pulled downward and areas denuded anteriorly on both sides.

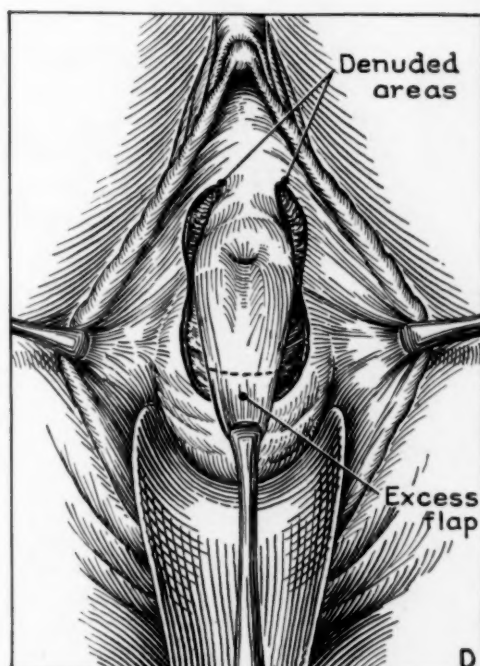
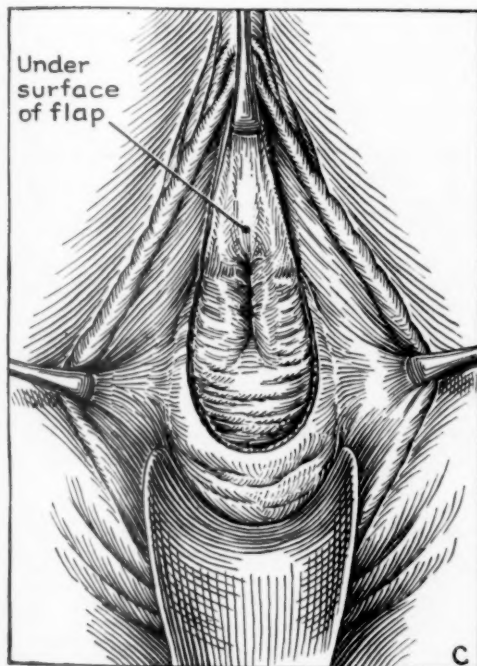
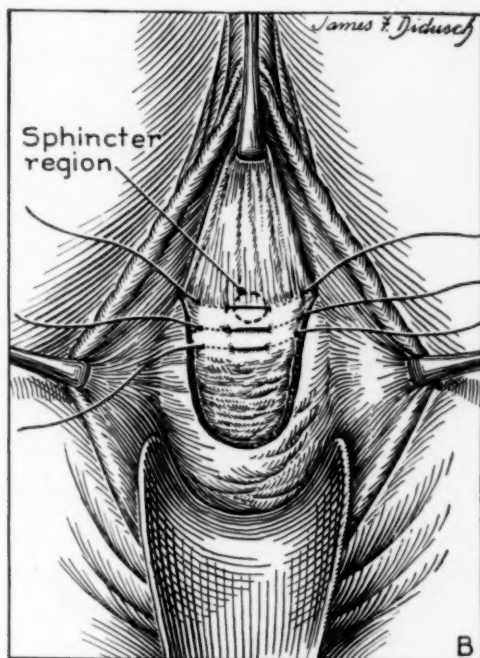
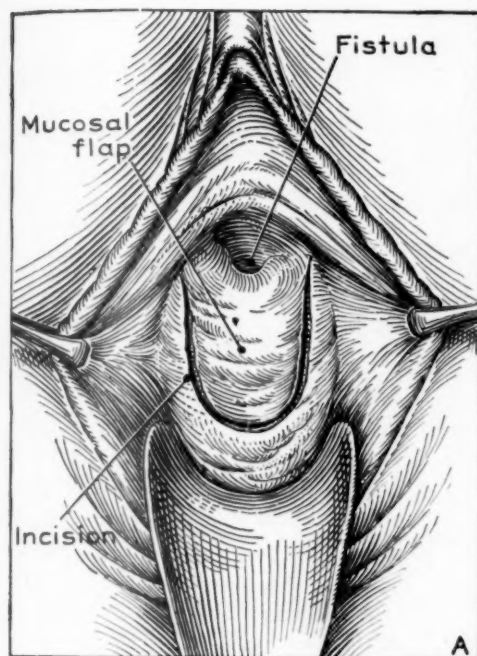


FIG. 12
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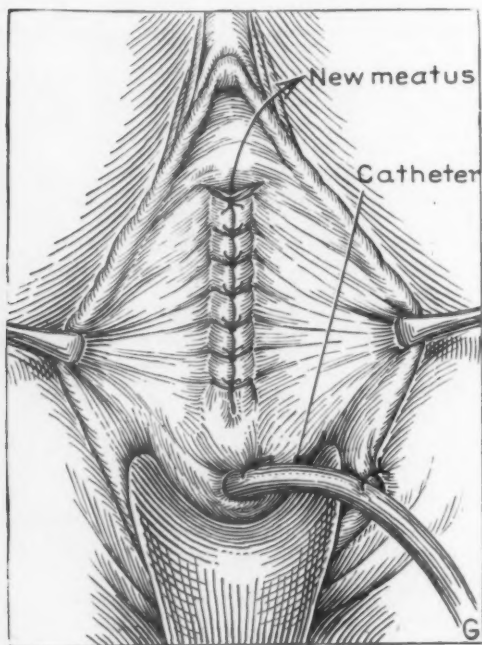
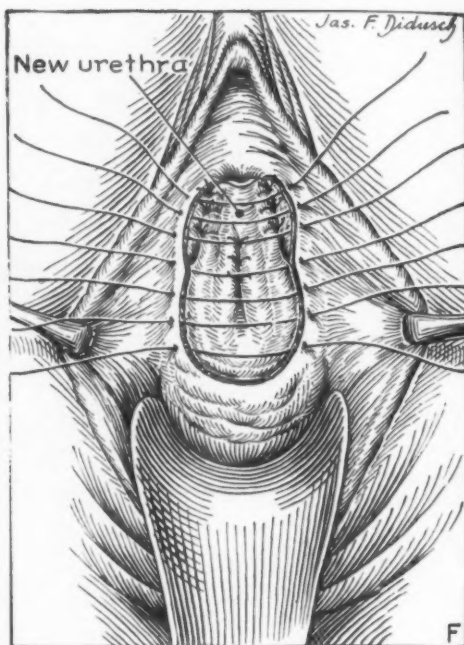
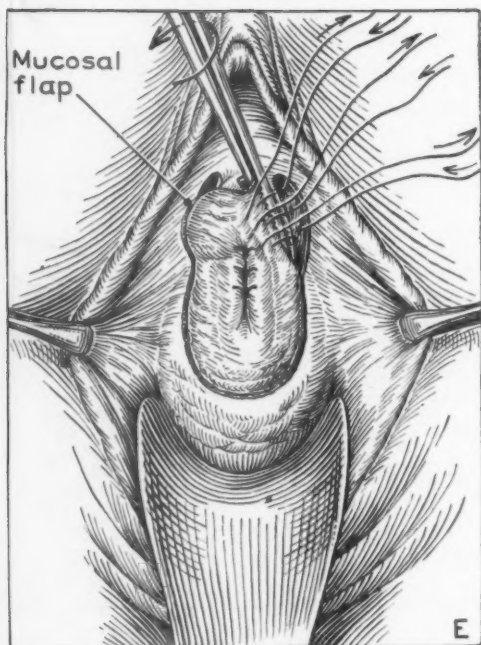


FIG. 12.—E. Flap is sutured anteriorly with No. 00 chromic catgut, rolling flap inward so as to approximate raw surface to raw surface.

F. Mucosal edges are approximated over the newly formed urethra with interrupted sutures of No. 0 chromic catgut.

G. Bladder is kept empty by means of a catheter in a surgically made vesicovaginal fistula, placed posterior to plastic work.

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sion. Often, however, it is possible to bring the bladder up to the severed ureter for a considerable distance. We have noted no advantage in attempting to perform the anastomosis retroperitoneally.

Just before operation the patient should be cystoscoped and a ureteral catheter passed as far as possible up the lower segment of the injured ureter. This enables the operator to identify the lower portion of the ureter easily. Without this precaution the lower segment, buried in the edematous tissues, may be located only with great difficulty. If uretero-ureteral anastomosis is done, the catheter can be pulled up and used as a splint for the anastomosis. The anastomosis is done in an end-to-end manner suturing the ureteral walls together loosely with No. 000 chromic catgut (Fig. 13). The catheter is left in the ureter for approximately ten days. During this time the patient is given chemotherapy prophylactically, fluids are forced and the catheter is inspected frequently to be certain that the lumen is patent. If it becomes obstructed, it should be irrigated, using a few cubic centimeters of sterile saline solution in a syringe.

In performing an implantation of the ureter into the bladder, the ureter is dissected free for a sufficient distance to permit its implantation. Excessive freeing of the ureter only strips it of blood supply and increases the danger of sloughing. Since most ureteral injuries occur during panhysterectomy, the uterus is out of the way and the ureter can be brought directly down to the vertex of the bladder. If the uterus has not been removed, the shortest path to the bladder is through a perforation in the broad ligament (Fig. 14). The lower end of the ureter is split for about 5 mm. and a substantial bite is taken into each part of the divided end, using No. 00 catgut. The vertex of the bladder is held with mucosa clips and a short incision made in it. The catheter, which had previously been inserted through the cystoscope up the lower

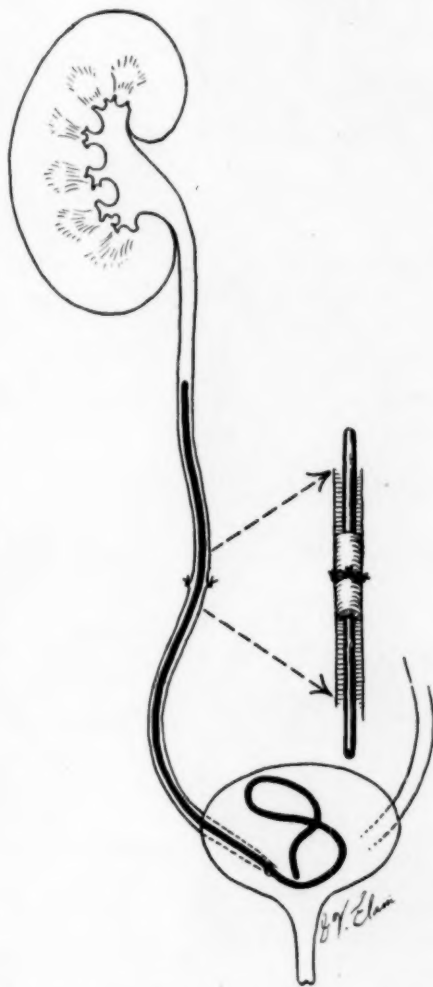


FIG. 13. — Uretero-ureteral anastomosis around ureteral catheter.

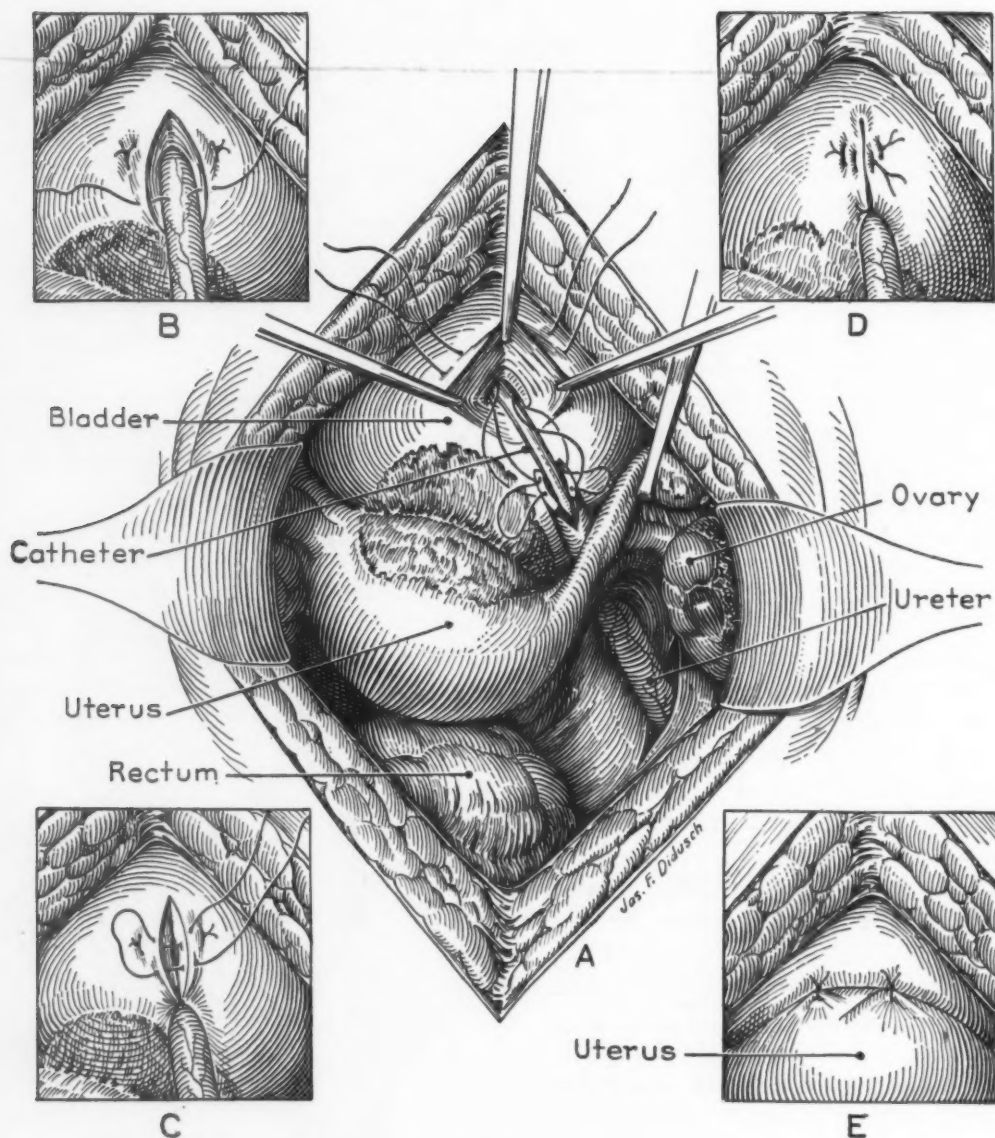


FIG. 14.—Implantation of ureter into bladder.

A. Ureter has been dissected free and cut across. Opening has been made through broad ligament into bladder, and end of catheter has been introduced into it. Mattress sutures have been placed in end of ureter, passed into bladder and cut through wall of bladder.

B. Mattress sutures have been tied and a fixation suture placed through bladder wall and muscular coat of ureter.

C. Bladder-wall incision is approximated with a mattress stitch.

D. This mattress stitch has been tied, and implantation has been completed.

E. Uterus and serosal surface of bladder are sutured together to relieve any tension that might develop at anastomosis.

segment of the severed ureter, is picked up in the bladder and the end withdrawn through the bladder opening. It is threaded up the ureter which is to be implanted for several centimeters. The four ends of the two sutures which were previously placed in the end of the ureter are then rethreaded on round needles and carried into the bladder and then out on opposite sides of the bladder incision (Fig. 14 A). These sutures are tied as shown in Figure 14 B.

A third stitch is taken to fix the ureter to the bladder wall (Fig. 14 B). A mattress suture, or two, are used to complete the closure of the bladder wall. If there is tension an attempt should be made to relieve it by fixing the bladder in a high position. If the anastomosis has been satisfactory, 5 Gm. of sulfanilamide powder is dusted into the operative field and the abdomen closed without drainage. If there is doubt about the quality of the anastomosis, a cigarette drain should be placed down to the operative region and brought out retroperitoneally through a small stab wound. As in uretero-ureteral anastomosis, the ureteral catheter is left in place for about ten days. A rubber urethral catheter is also left in the bladder and the catheters watched to make certain they are patent at all times. Chemotherapy is administered during the convalescence.

From reviewing our experience of the past decade, it is apparent that most cases of urinary incontinence are curable surgically. In order to effect a cure in a high percentage of cases, surgical principles which have evolved out of the experience of many operators during several decades must be heeded. Ingenuity in planning each case and meticulous care in executing the surgical procedures are essential, but the reward is a successful outcome, which transforms the life of the patient from an almost unbearable existence to that of a normal woman.

BIBLIOGRAPHY

- ¹ Kelly, Howard A., and Dumm, William M.: Urinary Incontinence in Women, without Manifest Injury to the Bladder. *Surg. Gynec. & Obst.*, **18**, 444, 1914.
- ² Watson, B. P.: Imperfect Urinary Control following Childbirth, and Its Surgical Treatment. *Brit. M. J.*, **2**, 566, 1924.
- ³ Furniss, H. Dawson: Incontinence of Urine Due to Relaxed Vesical Sphincter. *Am. J. Obst. and Gynec.*, **8**, 195, 1924.
- ⁴ Kelly, Howard A.: Incontinence of Urine in Women. *Urol. and Cutan. Rev.*, **17**, 291, 1913.
- ⁵ Kennedy, W. T.: Incontinence of Urine in the Female. *Am. J. Obst. and Gynec.*, **33**, 19, 1937.
Idem: Incontinence of Urine in the Female: The Urethral Sphincter Mechanism, Damage of Function, and Restoration of Control. *Ibid*: **34**, 576, 1937.
Idem: Urinary Incontinence Relieved by Restoration and Maintenance of the Normal Position of the Urethra. *Ibid*: **41**, 16, 1941.
- ⁶ Schumann, E. A.: Management of Urinary Incontinence in Women. *S. Clin. North America*, **16**, 445, 1936.
- ⁷ Baldy, J. M.: Incontinence of Urine, Complete and Incomplete. *Surg. Gynec. and Obst.*, **17**, 533, 1913.
- ⁸ Martius, H.: Sphincter and Harnröhrenplastik aus dem Musculus bulbo cavernosus. *Chirurg.*, **1**, 769, 1929.

- ⁹ Deming, C. L.: Transplantation of the Gracilis Muscle for Incontinence of Urine. J. A. M. A., **85**, 822, 1926.
 - ¹⁰ Goebell, R.: Zur operativen Beseitigung der angeborenen Incontinentia vesicae. Ztschr. f. Gynäk. n. Urol., **2**, 187, 1910.
 - ¹¹ Frangenheim, P.: Zur operativen Behandlung der Inkontinenz der männlichen Harnröhre. Verhandl. d. deutsch. Gesellsch. F. Chir., **43**, 149, 1914.
 - ¹² Stoeckel, W.: Über die Verwendung der Musculi Pyramidales bei der operativen Behandlung der Incontinentia urinae. Zentralbl. f. Gynäk., **41**, 11, 1917.
 - ¹³ Miller, N.: Surgical Treatment of Urinary Incontinence in Female. J. A. M. A., **98**, 628, 1932.
 - ¹⁴ Aldridge, A. H.: Transplantation of Fascia for Relief of Urinary Stress Incontinence. Am. J. Obst. and Gynec., **44**, 398, 1942.
Idem: An Evaluation of Methods for the Treatment of Urinary Incontinence. *Ibid*: **51**, 299, 1946.
 - ¹⁵ Studdiford, W. E.: Transplantation of Abdominal Fascia for the Relief of Urinary Stress Incontinence. Am. J. Obst. and Gynec., **47**, 764, 1944.
Idem: Further Experiences in the Use of Transplanted Abdominal Fascia in the Relief of Stress Incontinence. *Ibid*: **50**, 119, 1945.
 - ¹⁶ Van Roonhuysen, mentioned by Kelly, Howard A.: The History of Vesicovaginal Fistula. Tr. Am. Gynec. Soc., **37**, 3, 1912.
 - ¹⁷ Fatio, Johannas: *Ibid*.
 - ¹⁸ Hayward, G.: *Ibid*.
 - ¹⁹ Metzger: *Ibid*.
 - ²⁰ McHaver, J.: *Ibid*.
 - ²¹ Wützer: *Ibid*.
 - ²² Lamballe, J. de: *Ibid*.
 - ²³ Simon: *Ibid*.
 - ²⁴ Sims, J. Marion: On the Treatment of Vesicovaginal Fistula. Am. J. M. Sc., **23**, 59, 1852.
Idem: The Anniversary Discourse before the New York Academy of Medicine. Samuel S. and William Wood, New York, 1858.
 - ²⁵ Latzko, W.: Beitrag zur Operation Komplizierter Blasen-Scheiden fisteln nebst Bemerkungen zur Frage der Harnkontinenz. Zentralbl. f. Gynäk., **57**, 1026, 1933.
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DISCUSSION.—DR. EDWARD H. RICHARDSON, Baltimore, Md.: This exceptionally clear and comprehensive presentation by Doctor Te Linde leaves little to be added to the subject. Certainly, he is to be congratulated upon the high percentage of success he has obtained, especially in his management of the more difficult types of fistulae.

Of the many valuable lessons contained in this paper, time will permit me to focus attention upon only a few. First, the lamentable fact that the altogether unwise and inaccurate propaganda of recent years, advocating routine total hysterectomy for benign disease, has obviously led many surgeons who are inadequately trained to undertake this operation, with the inevitable result that postoperative urinary tract fistulae are multiplying all over the country at an inexcusable rate. This, too, in spite of the fact that several operative procedures have been devised that, if accurately imitated, would certainly reduce the incidence of this distressing sequela to a minimum. In 1929, after an intensive study of the anatomy involved, I published my technic for abdominal total hysterectomy, which is reproduced in Doctor Te Linde's recently published "Operative Gynecology." One of the main objectives in designing that operation was to avoid urinary tract fistulae, and if the technic described is rigidly adhered to, none should occur, as witness the fact that in my own series of cases since 1929 I have not had a single postoperative fistula develop.

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Secondly, we have been shown that there is no single operative procedure that can be successfully applied to all types of urinary incontinence. Each patient must first be comprehensively studied and all therapeutic factors marshaled for surgical attack that can in any way contribute to a successful operation. Obviously, this program must include a thorough preliminary general diagnostic study with therapy directed to attainment of the best possible physical and mental condition of the individual patient; it must include specifically an expert urologic study; it must take care that the tissues to be utilized for plastic repair are in suitable condition, that is, free from infection, edema and impaired circulation. All these factors may contribute to defeat if sufficient time, often a matter of six months, or more, is not allowed to elapse for tissue recovery subsequent to the original trauma or to repeated unskilled attempts at reconstruction.

Thirdly, we have been reminded of certain aids, the intelligent use of which often greatly simplifies the plastic procedure. Included among these are (1) optimum exposure, to be obtained by choice of posture (the dorsal posture with elevation of the hips, the Sims posture or, occasionally, the knee-chest posture); by utilizing episiotomy or Schuchardt's pararectal incisions; and by the use of properly placed traction sutures; (2) indwelling catheters in the ureters to avoid occlusion by sutures; (3) the combined extraperitoneal abdominal and vaginal approach when essential to success; and (4) delicately constructed instruments specifically designed for this work.

Finally, emphasis has properly been placed upon strict observance of the fundamental principles of plastic surgery; namely, (1) free mobilization of the margins of the fistula by liberal dissection of the vaginal wall from the bladder on all sides; (2) excision of scar tissue along the margins to a vascular base; (3) judicious hemostasis; (4) accurate approximation of the margins, with an adequate zone of adjacent bladder wall; (5) avoid inclusion of bladder mucosa between the approximated margins; (6) avoid excessive use of sutures lest ischemic necrosis result; (7) avoid a vertically superimposed suture line in closing the vaginal wall and use fine silver wire for the latter, so placed as to obliterate all dead spaces but not penetrate the bladder mucosa; (8) the use of a therapeutic secondary fistula, either vesicovaginal or suprapubic, as may be indicated, with an indwelling catheter to keep the bladder at rest for 12 to 14 days; and (9) meticulous postoperative supervision.

These are the guiding principles in the successful management of urinary incontinence in women, and I am sure that all of us will agree that Doctor Te Linde's slides, together with his discussion of the subject and his excellent statistics, prove quite conclusively that not only is he quite familiar with all of them but also that he possesses uncommon skill and resourcefulness in their practical application.

DR. CURTIS H. TYRONE, New Orleans, La.: We are indebted to Doctor Te Linde for his very excellent portrayal of this subject, and to Doctor Richardson for his comment. I can certainly agree with him that the number of fistulae from hysterectomy is increasing, and in the last ten years I have seen only one case in which the fistula was due to obstetrical injuries.

Doctor Te Linde stressed the use of silver wire in the correction of vesicovaginal fistulae. I was "raised" on silver wire, but in the last few years I have become converted to cotton. The use of cotton after the bladder mucosa has been closed has worked very successfully in the last few years. I think one most important point in closure is thorough mobilization of the bladder mucous membrane.

GANGRENE (NONINFECTIVE) COMPLICATING FRACTURES*

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LITERATURE ON FRACTURES as well as on circulatory disturbances is extensive. Published observations on soft tissue and vascular damage associated with fractures are comparatively rare.

Since soft tissue injuries are extremely common, this represents somewhat of a paradox. Even though the majority of fractures do not present gross evidence of soft tissue injury, it is inconceivable that some damage has not occurred. Fortunately, most of this ultimately proves to be of relative unimportance. However, is it not possible that in emphasizing the treatment of the tangible—the fracture—we have, to a certain extent, minimized the implications of that which is often intangible; *e. g.*, soft tissue injury? Fractures are often the sequela to an injury which, of itself, monopolizes all attention, and anything else appears to be of relative unimportance. Perhaps it would be a better policy to emphasize and discuss more frequently the potential complications of fractures. Certainly, we should not act as though they were nonexistent. By adoption of such an attitude, adeptness would be gained in treating the usual, as well as anticipating the unusual. Assuredly, anticipation of the possibility of vascular complications would often prevent the development of gangrene, and subsequent loss of an extremity.

In the concept of treatment of fractures, the edict of "splint them where they lie" cannot be overemphasized. However, once beyond that point, a too unimaginative attitude toward proper alignment and fixation of a fracture is frequently revealed, with consequent failure to properly focus attention on possible soft tissue complications, particularly those of vascular or neurogenic character. Once proper immobilization of a fracture has been obtained, it would be wiser to thoroughly evaluate the influence of original trauma rather than attempt to differentiate the possible contributing effects of manipulative procedures. In 1934, Dodd compiled 29 cases of vascular injury complicating fractures of the extremities from world literature and reported two additional cases. The report covered a period from 1850 to 1934. From 1934 to 1942, nine additional cases were reported. Child, in 1942, in reporting a case, reviewed the problem in its relationship to the lower extremity. These two reports represent a recompilation of the 40 cases appearing in world literature from 1850 to 1942.

King and Brewer, in 1944, reported four cases, associated with fractures about the knee, all of which required amputation. They believe that the site of the fracture, rather than the displacement was the important causative

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factor. In that same year, Mock and Tannehill reported two cases of gangrene of the lower extremity associated with fractures of the pelvis.

Considering the high incidence of fractures, the condition is apparently strikingly rare. Ormsby, in 1911, made the following pertinent observation: "The complication of gangrene is an uncommon one if I am to judge from the meager reference to it to be found in the literature at my command."

It is the purpose of this paper to report three additional cases. The first two cases, those of popliteal thromboses, came under personal observation. The third case, that of a torn brachial artery, was obtained from the University Hospital case reports. The interest in each patient is not in the fracture, *per se* but in the complication. Therefore, only cursory mention of the type and character of fracture will be made. In each instance, contradictory as it may seem, subsequent events proved that the fracture was of minor consequence when compared to the degree of vascular damage. All three cases developed extensive gangrene as the result of vascular injury associated with fractures. Amputation was required in each instance. Each patient recovered.

CASE REPORTS

Case 1.—White, male, age 28, was admitted to the hospital approximately two hours after having fallen 30 feet. Injuries were sustained to both lower extremities, resulting in comminuted fractures of the lower third of the right tibia and fibula; as well as the upper third of the left tibia, and the lateral condyle of the left tibia and left patella.

When admitted to the hospital, both lower extremities were immobilized in Thomas leg splints. The toes were normal in color and sensation intact. No evidence of soft tissue damage was noted except for multiple contusions. Peripheral vessels were not palpated for pulsations.

Under sodium pentothal anesthesia, the fractures were reduced on the day of admission. Two attempts were made before the lateral condyle of the left tibia was considered to be in satisfactory position. Both lower extremities were encased in plaster.

During the next two days nothing unusual was noted, except for the development of pain in the left foot and leg that gradually increased in severity. On the fifth day after admission, definite evidence of circulatory embarrassment in the left foot was presented. The toes were cold and cyanotic. Encasement was removed and immobilization maintained by means of sand-bags. The left popliteal, dorsalis pedis and posterior tibial arteries were not palpable. Despite supportive measures directed toward stimulating the collateral circulation, the involved foot, ankle and lower two-thirds of the leg became gangrenous. A supracondylar guillotine-type of amputation was performed, ten days after the initial injury.

Recovery was without event.

Subsequent pathologic examination revealed a thrombosis of the popliteal artery at its bifurcation.

Case 2.—White, male, age 23, incurred a transverse fracture of the left femur with moderate displacement at the junction of its lower and middle third. There was no visible evidence of soft tissue damage and notation was not made of associated vascular or neurogenic injury.

An immediate reduction of the fracture was performed under sodium pentothal anesthesia and immobilization maintained by encasement in a plaster cast. Upon recovery from anesthesia, complaint was made of excruciating pain. It was noted that the toes were discolored and cool. The encasement, which was relatively loose-fitting, was not considered a contributing factor, and, therefore, was neither removed nor bivalved.

When seen in consultation on the third day after the accident, the toes and foot were deeply cyanotic. The encasement was removed. The entire leg was cold and mottled. No pulsations were obtained in the popliteal, dorsalis pedis or posterior tibial arteries of the involved extremity. Supportive measures which were directed toward stimulating the collateral circulation were inadequate. Gangrene developed, and on the tenth day after the initial injury, an amputation was performed at the fracture site.

Subsequent pathologic examination revealed an organizing thrombus of the popliteal artery at its bifurcation, with complete occlusion of the lumen. The dorsalis pedis artery also presented an organizing thrombus. The muscles of the leg were edematous and under considerable pressure within their fascial sheath.

COMMENT: Supportive measures in Cases 1 and 2 consisted of the use of intravenous papaverine hydrochloride; heparin and paravertebral sympathetic blocks.

No attempt was made to localize the thrombus. No part of the vascular trunk was explored.

A fasciotomy, if it had been performed in Case 2, might have been of value.

Case 3.—White, male, age 57, fell from a scaffold and incurred a posterior displacement of the right elbow and a comminuted impacted fracture of the distal end of the right radius.

The family physician, after reducing the dislocation and attempting to reduce the fracture, placed the arm and forearm in a plaster encasement. Forty-eight hours later, it was noted that the right hand was cold and painful. During the next 24 hours discoloration of the fingers was observed. The encasement was removed from the arm and elbow region.

Discoloration increased, and three days later, or six days after the initial injury, the remainder of the encasement was removed, at which time a dry gangrene of the forearm was noted. Two days later, when an amputation was performed through the lower end of the arm, the gangrenous process included the entire hand and forearm to within about three inches of the elbow.

Subsequent pathologic examination revealed a tear in the brachial artery that included about two-thirds of its circumference. There was an extensive hematoma in the antecubital fossa and extravasation of blood along the artery. A thrombus occluded the distal part of the brachial artery and extended the entire length of both the radial and ulna arteries. Blood vessel walls were within histologically normal limitations for an individual this age.

COMMENT: These three cases, although representing a comparatively rare entity, are presented for critical review because of their importance. Proper anticipation, early diagnosis and adequate evaluation of this type of complication are the important factors in preventing the catastrophe of gangrene. Appreciation of the possible implications of trauma to the vascular system should lead to more satisfactory end-results.

Age Incidence.—Child, in his critical analysis of 15 cases demonstrated an average age of 26 years. He thought that "degenerative diseases of the arterial wall, as a predisposing factor, could largely be discounted.

Dodd mentioned calcification of arteries; syphilis and diabetes as predisposing factors.

The average age for the two cases of thrombosis herein described was

25.5 years. No evidence of arterial degenerative disease was noted in any of the three cases in this series.

Artery Occluded.—In vascular occlusions there is a direct relationship between the character and importance of the involved artery and the degree of circulatory embarrassment. In this series, two cases showed an occlusion of the popliteal artery at its bifurcation. The third case presented an interruption to the continuity of the brachial artery by partial severance near its bifurcation. Dodd indicated that in association with extremity fractures, the femoral, popliteal and brachial arteries are more susceptible to injury than other peripheral vessels. He believes that the explanation for this predilection is the relative greater fixation of these vessels. A relatively mobile vessel will be less apt to be involved in accidents, than one more fixed by fascia, aponeurosis or other anatomical factors or in close proximity to bone.

In his survey of the subject, Dodd points in particular to the vulnerability of the popliteal artery at its bifurcation and states: "This is anchored by the fibrous arch of the soleus, by the passage of the anterior tibial artery over the interosseous membrane, by its proximity to the fibula and by the origins of small anastomotic branches of the knee joint." He, furthermore, discusses the comparatively intimate association of the bifurcation with the neck of the fibula, and points out that the anterior tibial artery makes a slight groove on the inside of the neck of the fibula as it passes from behind to the front compartment of the leg.

Site and Extent of Fracture.—This is apparently not a predisposing factor except in its anatomic relationship to the involved artery.

Method of Treatment of Fracture.—Although it is impossible to refute indictment of encasement, particularly in Cases 1 and 2, it is probable that this method of immobilization was not related to the complication. Child, in analyzing 13 cases, noted that six had been treated by traction; five with encasements, and two without either of these aids to fixation.

Results.—In the three cases herein reported, amputation was required. There were no deaths. Dodd, in his analysis of 31 cases, reported amputations in all but four cases. Previous to 1918, the mortality rate was strikingly high. The lowered mortality rate since 1918 is attributed to refinements in aseptic technic, rather than operative improvements.

DISCUSSION.—Interruption of blood supply, with inability to establish compensatory collateral flow, will result in death of tissue.

Interruption of blood supply may be produced by penetration, complete division or partial rupture of an artery. Intimal damage either by contusion, rupture or persistent pressure effect will result in occlusion of the vessel with thrombus formation. Leriche believes that thrombosis of an artery or vein is probably the most frequent cause of vasoconstriction and associated spasm. He states that as soon as the inflammatory process in its wall reaches the nervous elements of the latter, it stimulates them and this stimulation produces a distal vasoconstriction in the still permeable portion of the artery and over the whole collateral network. Excision of the obliterated segment results in a much more active collateral network. Conversely, segmental spasm—

"*stupeur arterielle*"—may be due to direct stimulus and if allowed to persist for any great length of time may lead to thrombus development. It is possible that the latter phenomena is a major contributing factor in the production of this condition. The sympathetic responds to all stimuli by a hyper-tonus which lessens the arterial caliber of normal tonus. Simple manipulations and handling of blood vessels will often produce prolonged spasm. It is a condition that is frequently seen in operative procedures. Where there has been trauma or violence of any character, every attempt should be made to evaluate the resultant extent of soft tissue injury, especially in its relationship to vasospasm and vascular interference.

Prolonged pressure effects from edema, tense fascial planes and encasement under certain conditions may be indicting factors in the production of arterial occlusion.

TREATMENT

Treatment is a matter of early diagnosis and timely decision. Inevitably, gangrene requires amputation. To avoid amputation, gangrene must be prevented; to prevent gangrene, the circulation must be adequate; and to maintain an adequate circulation, it must be anticipated that it is possible for it either to be, or to become inadequate. This can only be accomplished by individual evaluation of all factors concerned.

If evidence of circulatory embarrassment is discerned and it is believed that bone fragment displacement is not the causative factor, then preferably, the vascular system should be supported, before manipulation for perfect apposition is attempted. If, in every case of fracture, the possibility of gangrene were anticipated, this complication might be averted. Particularly, emphasis should be placed on an evaluation of the status of the peripheral circulation. Failing or absent arterial pulsation, loss of sensation, coldness, cyanosis and pain should be evaluated as being prognostic of imminent circulatory embarrassment. Once suspected, definite and immediate measures should be adopted to support the circulation.

Paravertebral blocks for the dual purpose of overcoming associated spasm and dilating the collateral blood vessels should be effected. Heparinization, if thrombosis is suspected, should be instituted. The peripheral circulation should be supported by the use of antispasmodics, such as papaverine hydrochloride and liberal sedation. Lowering the metabolic demands by wrapping the extremity in gauze kept moistened with alcohol, as a modified form of refrigeration, will occasionally be found to be of value.

Large hematomas should be incised both to relieve pressure and explore for an injured vessel. When possible, damaged vessels should be repaired either by suture or free venous graft.

Analysis of the cases on record indicates that usually some warning of the imminence of this type complication is given. Careful evaluation and appreciation of the requirements for maintenance of tissue viability may result in the avoidance of this catastrophe.

GANGRENE COMPLICATING FRACTURES

SUMMARY

The problem of noninfective gangrene following fracture is reviewed.

Three additional cases are recorded.

Factors in diagnosis are discussed in addition to therapeutic measures.

REFERENCES

- ¹ Dodd, Harold: Gangrene following Fractures (Excluding Gas Gangrene). *Brit. Jour. of Surg.*, **22**, 246, 1934-35.
- ² Von Susani, O.: Über Beingangrän bei Unterschenkelbrüchen. *Deutsche Zeitschrift f. Chirurgie*, **240**, 771, 1933.
- ³ Curry, G. J., and Bishop, D. L.: Diastasis of the Superior Tibia Complicated by Gangrene. *Jour. Bone and Joint Surg.*, **19**, 1093, 1937.
- ⁴ Fitte, Marcilo: Gangrene of the Foot due to Supramalleolar Fractures. *Prensa med. Argent.*, **25**, 194, 1938.
- ⁵ Fitte, Marcilo: Traumatic Gangrene due to Closed Fractures of Extremities. *Bol y trab. Soc. de cir. de Buenos Aires*, **23**, 508, 1939.
- ⁶ Ottolenghi, C. E., and Spinelli, C. A.: Grave Vascular Complications of Closed Fractures. *Rev. ortop. y traumatol.*, **9**, 90, 1939.
- ⁷ Child, C. G., III: Noninfective Gangrene following Fractures of the Lower Leg. *ANNALS OF SURGERY*, **116**, 721, 1942.
- ⁸ King, J. M., and Brewer, B. J.: Gangrene Complicating Fractures about the Knee. *Surg., Gyn. & Obst.*, **78**, 29-35, 1944.
- ⁹ Mock, H. E., and Tannehill, E. H.: Fractured Pelvis Complicated by Gangrene of Extremity: Amputation under Refrigeration Anesthesia. *Surg., Gyn. & Obst.*, **78**, 429-433, 1944.
- ¹⁰ Leriche, Rene: *The Surgery of Pain*, Chap. IX: 230-254.

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DISCUSSION.—DR. FREDERICK A. BOTHE, Philadelphia, Pa.: I hesitate very much to speak of one case; however, I wish to present the case of a boy, age 17, who received a fracture of both bones of the right leg in a football game. The bones were in excellent position. There was very little swelling of the leg when he was seen a few hours after the injury. The pulsation of the large vessels distal to the site of injury was not determined. The fragments were molded into position and a plaster encasement was applied. The patient was seen 24, 48, and 96 hours after the application of the encasement. The foot was warm, normal in color, and there was no swelling. On the 7th day, while attending a football game, he was jostled in the crowd and again injured the same extremity. That evening there was some tingling in the knee, the next day the toes were swollen and cyanotic, and tactile sense was gone. He then returned for an examination. In view of the above findings the encasement was removed at once and the foot elevated. There was improvement in the local findings, but not so much as we desired. We were unable to palpate any pulsation of either the posterior tibial or dorsalis pedis arteries. At this time, tactile sense was absent to the middle of the calf. We packed the foot and leg in ice and used repeated sympathetic blocks, but were discouraged by the response to this form of treatment.

Dr. M. C. Peterson, of New York, suggested the use of novocaine intravenously instead of the sympathetic block. We prepared a solution in which 1 Gm. of novocaine was dissolved in 1,000 cc. of normal saline. Three hundred cubic centimeters of this solution was administered intravenously every eight hours, with a surgical resident in attendance. We felt that an equal and possibly greater response occurred from this procedure than from the sympathetic block, and, surely, it is much more easily administered. After 48 hours of this treatment we could get a pulsation of the posterior tibial

artery. The refrigeration was omitted from time-to-time for a few hours to note any local change. At the end of the 4th day the refrigeration was discontinued as we no longer noted any local change when we omitted it for several hours. Now, 11 days since we started intravenous novocaine, the phalanges of four toes are gangrenous but the rest of the foot appears improved.

This case is presented, not because of the result obtained, but to report the use of novocaine intravenously in the management of cases of peripheral vascular disease. Peterson is studying its use in such cases.

DR. JAMES S. SPEED, Memphis, Tenn.: Doctor Yeager's paper is of great interest and importance to those who engage in the treatment of fractures and other traumatic injuries. It calls our attention to the importance of a careful record on these injuries regarding the possible vascular and neurologic damage at the time of the original examination. This is of importance, not only in the treatment of the patient but from a medicolegal standpoint as well. Vascular and neurologic injuries of this type usually occur in association with fractures at two sites: fractures about the elbow joint; and fractures or epiphyseal separations about the upper end of the tibia or lower end of the femur. The adjacent vessels and nerves are frequently injured at these sites.

The two direct surgical attacks to improve the circulation at the time of the acute injury, embolectomy and spreading of the fascial covering of the muscles about the site of injury, have proved somewhat disappointing in my experience. We have found it difficult in most cases to determine at the time of the acute injury whether the vascular damage is temporary or permanent, or whether it is of sufficient severity to jeopardize treatment of the fracture by the institution of such procedures. Frequently, by the time a decision has been made in regard to this, the tissue damage due to circulatory disturbance has progressed to a point where these procedures may be of little value.

Sympathetic block by any of the accepted procedures has proved to be of considerable help in differentiating between serious permanent vascular lesions and temporary vascular disturbances due to vasospasm. Temporary sympathetic block by means of novocaine or alcohol injection is uncertain and transient in its effects.

In many cases, where the associated injury has produced serious shock, the addition of any major surgical procedure is inadvisable. In these cases continuous caudal anesthesia for vascular disturbance in the lower extremities has been found to be very helpful. It has been continued in one of our cases for seven days without any deleterious effects. It is possible that, when additional experience and knowledge have been gained in the use of tetra-ethyl-ammonium, that this will prove to be an agent of choice, both as a therapeutic measure and as a diagnostic measure, in many cases.

It is important from a medicolegal standpoint to have recorded that vascular disturbances of serious nature may occur in extremities where no type of constricting bandage or immobilization has been used.

DR. GEORGE E. BENNETT, Baltimore, Md.: From time-to-time one sees a fracture of the lower leg in which there is complete blanching of the tissue below the line of fracture and lack of pulsation of the vessels of the foot. After the fracture has been reduced and held in position manually for a period of a few minutes, and blushing of the skin and circulation does not return, then I think one is perfectly justified in dividing the fascia of the calf of the leg to relieve this pressure, just as one would do in the upper arm associated with fractures of the elbow. I have done this on many occasions and I feel quite sure that I have saved many patients serious circulatory complications of the leg.

DR. J. M. DONALD, Birmingham, Ala.: I wish to express my appreciation for Doctor Yeager's splendid presentation of this very important subject and to report a somewhat similar case: Complete laceration of the popliteal artery following posterior dislocation of the left knee, with resulting gangrene of the leg requiring amputation.

GANGRENE COMPLICATING FRACTURES

Case Report.—This 27-year-old white male was brought to the Hillman emergency room on the night of January 16, 1946, shortly after an automobile accident near Birmingham. The patient stated that he was a passenger and was asleep in a truck which overturned. He was found thrown from the car and was wedged between the car door and a tree. On admission, the patient was in severe shock. There was pain and swelling about both knee joints. After treatment for shock and application of Thomas leg splints to both lower extremities, he was admitted to the surgical service of the Jefferson Hospital.

About three hours after admission it was noted that the left foot was cold, whereas the right foot was warm. Traction was immediately released from the left leg and ice bags were packed around the leg. No pulsation could be felt in the left dorsalis pedis or posterior tibial arteries. The patient complained of severe pain in the left leg. Left lumbar sympathetic blocks were done without apparent benefit. Roentgenologic examinations revealed no evidence of fracture of the left leg. Roentgenologic examination of the right knee revealed a comminuted fracture of the anterior lip of the right tibial condyles and an incomplete fracture through the head of the right fibula.

After two days of conservative therapy there was no improvement in the circulation of the left leg. The left calf was ecchymotic, edematous and tense. The left foot was cold and blanched. Dr. J. M. Mason III saw the patient in consultation and advised fasciotomy and exploration of the left popliteal space. These procedures were carried out under spinal anesthesia. The left popliteal artery was found to be completely severed just proximal to its bifurcation. The popliteal vein was thrombosed. The ligaments of the knee joint were extensively torn. The severed popliteal artery was extremely spastic and a thrombus was present in each end. Due to the tearing effect of the injury, suture of the artery was impossible. The ends of the artery were ligated. The popliteal wound was closed. After dressing the fasciotomy wounds the leg was well padded and placed in a plaster encasement which was immediately bivalved.

In spite of repeated lumbar sympathetic blocks, gangrene of the foot and leg progressed.

On January 23rd, seven days after injury, amputation of the left leg above the knee was performed under spinal anesthesia. The wound was closed primarily. An encasement was applied to the right leg on January 28th. The patient improved rapidly. Convalescence was uneventful. The patient was discharged from the hospital in good condition on February 10, 1946.

This case serves to emphasize the seriousness of injury to the popliteal artery. It seems probable, since no fracture was demonstrable, that the tearing of the artery was due to dislocation of the knee joint.

DR. J. WARREN WHITE, Greenville, S. C.: One point would bear emphasizing, that is, the value of cold. Doctor Yeager mentioned the use of alcohol but not the use of ice and ice packs. I think this is one point that should be considered and would be of real help. In the cases cited probably nothing could have been done. If, in the face of threatened gangrene, you can lower the metabolic requirement you might protect the leg until you get restoration of circulation. Another point deserving emphasis is to elevate the extremity, as I am sure we always do. I use the ice bag postoperatively in all cases, if only for the comfort of the patient.

DR. I. R. TRIMBLE, Baltimore, Md.: In these very acute emergencies I would like to make one plea on treatment. A great many of these patients should be subjected immediately to lumbar sympathectomy through the extraperitoneal approach. It is easily done, taking only a few minutes. If the leg is in danger because of poor circulation a real emergency exists, and we should not wait until developments of a serious nature have taken place. If there is no pulsation at the time of injury and examination shows that fasciotomy should be done, well and good. On the other hand, in any injury with spasm of the large vessels there is always great spasm of the accompanying vessels. This can be relieved by sympathectomy. The trouble with injections is that it is not known how long they will last. It is difficult sometimes to turn the patient in bed to subject him to multiple injections. I think instead of continuous spinal anesthesia of a week's duration, short spinal anesthesia and sympathectomy would be more reasonable. Once that is done you know you have given all the supporting measures you can to increase the collateral

circulation in that leg, and I think we are going to find that in the future we shall resort to actual sympathectomy rather than to injections or other measures.

DR. GEORGE H. YEAGER, Baltimore, Md., (closing): I want to thank all the discussers. I have had no experience with intravenous novocaine. The recommendation is most pertinent. Two of the patients were seen under conditions where ice was not available. We are using modified refrigeration where it is possible. When ice is not available or advisable, gauze saturated with alcohol over the involved extremity will prove of value. I agree with Doctor Trimble that ganglionectomy is the effective method of overcoming vasospasm. Unfortunately, the diagnosis is usually made late and not at the time trauma occurs. At the time of identification thrombosis has already occurred. With evidence of gangrene presenting, it is difficult to rationalize a major operation to prevent a condition that has occurred. Possibly, one might be justified in considering excision of vessels or resection. This will accomplish much in overcoming vasospasm.

SHOULDER AND ELBOW LESIONS DISTINCTIVE OF BASEBALL PLAYERS*

GEORGE E. BENNETT, M.D.,

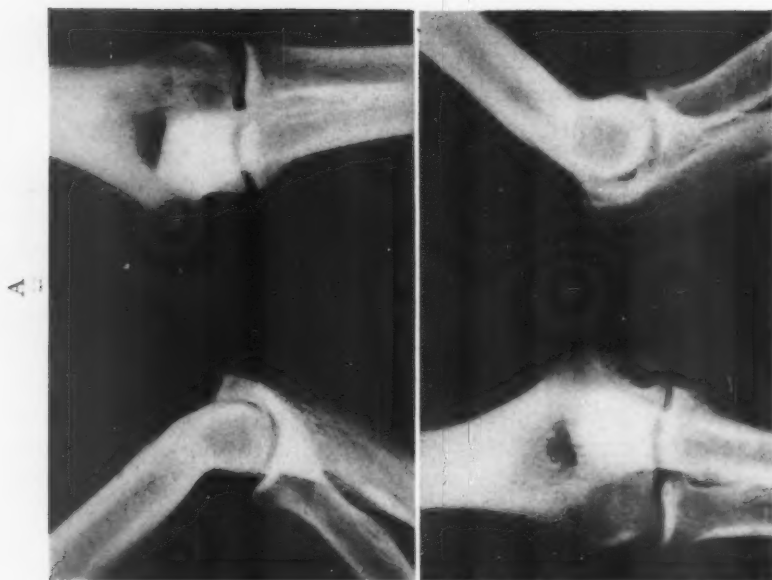
BALTIMORE, MARYLAND

IN A FORMER PUBLICATION¹ I stressed the point that the professional baseball player was a human being, not a superman, and that he was susceptible to all of the common lesions of the shoulder which we see in the non-ball player, namely, subacromion and subdeltoid bursitis, irritation of the supraspinatus and biceps tendons, traumatic synovitis and inflammatory disease. Fortunately, these conditions form the largest group and respond well to rest, heat and general orthodox treatment. Because a man is a ball player does not mean that he cannot have abscessed teeth, infected tonsils, or other foci of infection; therefore, his general health should be thoroughly investigated, just as one does when in search of some obscure etiologic factor in joint lesions.

His occupation is such, however, that aside from these common joint complaints he develops distinctive lesions. One which has been definitely identified and, to my knowledge, is nonexistent in other occupations, is a deposit on the posterior and inferior margin of the glenoid fossa, on or about the attachment of the triceps tendon. This is the result of the abnormal strain which is placed on the shoulder in throwing a baseball. As the arm swings forward in a flail-like movement with complete relaxation of the muscles of the shoulder, which is so essential for a pitcher to be effective, a tremendous strain is thrown upon the posterior shoulder and, as a result, deposits or exostoses develop in close proximity to the circumflex nerve and this nerve becomes irritated and causes marked referred pain to the shoulder joint, particularly in the region of the deltoid muscle. This is one of the distinctive lesions which very often ends the career of a professional pitcher as, in my opinion, it does not respond well to surgery. The cause is abnormal use of the shoulder and the deposits cause no discomfort or inconvenience except when throwing a baseball hard (Fig. 1).

The second lesion is a fraying of the supraspinatus tendon, which I do not think we can class as distinctive, because one sees it in individuals engaged in other occupations. The constant snubbing of the supraspinatus tendon over the head of the humerus and the greater tuberosity results in a gradual fraying of the deeper structures of the supraspinatus tendon. This is usually a lesion of a veteran pitcher after many years of professional baseball. On exploring these shoulders the outer surface of the supraspinatus tendon looks perfectly normal but a linear incision in the fibers of the tendon will show fraying of

* Read before the 58th Annual Session of the Southern Surgical Association, Hot Springs, Va., December 11, 1946.



FIGS. 2A and 2B.—Typical small osseous growth in the ligamentous tissue posterior and inferior to the internal epicondyle.



FIGS. 1A and 1B.—Characteristic deposits on the posterior-inferior border of the glenoid.

DISTINCTIVE BASEBALL INJURIES

that portion which is in contact with the humerus. Again, I do not think this is a remedial lesion. It is the result of prolonged use and abnormal irritation and does not respond to surgery. It also is a condition which causes no discomfort except when throwing a baseball hard.

The common pathologic processes of the elbow joint in the professional ball player are strikingly similar to those seen in non-ball players—loose bodies, single or multiple, either in the olecranon fossa, about the head of the radius or about the coronoid process. Generalized osteo-arthritis is also seen in non-ball players. There are, however, two lesions of the elbow which I

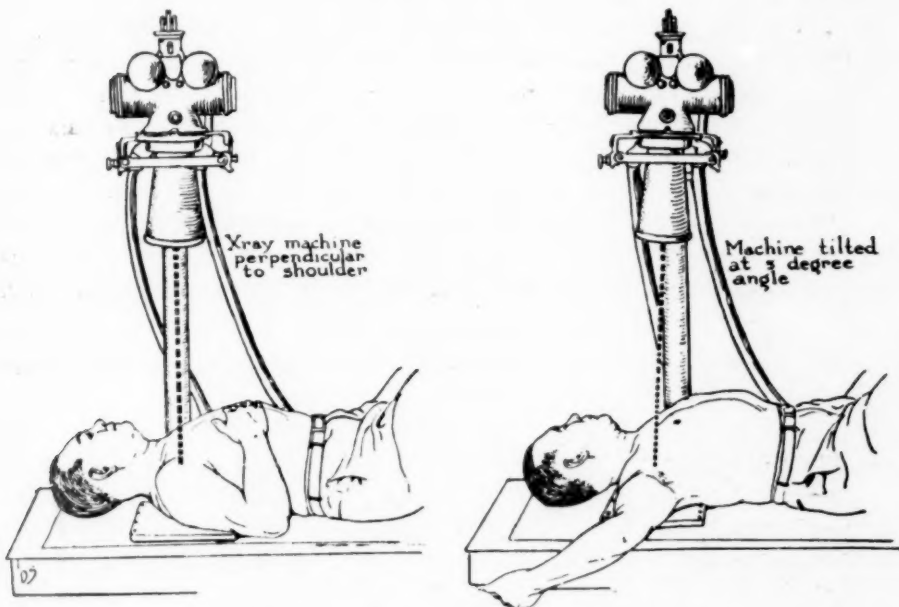


FIG. 3.—The exostosis or deposit in the posterior inferior region of the glenoid cannot be identified by the ordinary anterior posterior or posterior anterior view of the shoulder. Our x-ray technician, Mr. W. Ross Mitchell, developed the technic shown here. External rotation of the humerus with tilting of the x-ray tube about 5 degrees is the position which rotates the head of the humerus and the glenoid to a position which throws the thickened area in relief. (J. A. M. A., 117: 510-514, 1941).

think are distinctive. A pitcher in throwing a curve ball is compelled to supinate his wrist with a snap at the end of his delivery. This movement plus extension leads to the development of an irritation in front of the internal condyle of the humerus which is extremely disabling and very often ends his career. On examination one will note distinct fullness over the pronator radii teres, beneath which are the tendinous attachments of the brachialis and the flexor sublimis digitorum. These are covered by a very strong fascial band, a portion of which is the attachment of the biceps, which runs obliquely across the pronator muscle. A pitcher may be able to pitch for two or three innings when the pain and swelling becomes so great that he has to retire. Roent-

genograms in the majority of cases are entirely negative, and on exploration the joint reveals very little. The muscle tissue generally is normal in appearance. The simple division of the fascia covering the muscles has, on occasions, rehabilitated these men so that they were able to return to the game. I am at a loss to explain it except that tension develops from some unidentified irritation to the muscle tissue which at times has an ischemic appearance. It is quite possible that this may be a secondary irritation which is the result of lipping of the ulna at its articulation with the internal condyle, because on rare occasions we see osteophytic processes here which are linked with the condition which I am endeavoring to describe. I am not clear in my own mind as to its exact pathology. I trust that further study and observation will clear up this point because I feel that it should be a remediable lesion.

The most distinctive lesion, and one which is not seen in other occupations, is the development of single or multiple deposits of bone or ossicles in the ligamentous tissue and tendinous attachments beneath the ulnar nerve and not within the joint. I am quite sure that these deposits are purely the result of chronic strain and probably take years to develop, and in many instances give no symptoms. When they begin to cause irritation of the ulnar nerve they can be removed with success. Identifying these small masses of bone in the ligamentous tissue and dissecting them free will relieve symptoms in most cases.

REFERENCE

- ¹ Bennett, George E.: Shoulder and Elbow Lesions of the Professional Baseball Pitcher. J. A. M. A., 117, 510, August 1, 1941.
- ⁴ E. Madison St.
Baltimore 2, Md.

MEMOIRS

HOWARD MERRILL CLUTE

1890-1946

DR. HOWARD MERRILL CLUTE was born in North Berwick, Maine on January 10, 1890 and died in Boston, September 19, 1946. He was graduated from Dartmouth College in 1911 and from the Dartmouth Medical School in 1914. He received an honorary degree of Doctor of Science from Dartmouth in 1941.

He did his graduate work in surgery at the Boston City Hospital and then entered military service during World War I, receiving the rank of Major upon discharge.

After a long and successful association with Dr. Frank Howard Lahey, he entered private practice in Boston in 1935. One year later, he was made professor of surgery of the Boston University School of Medicine and surgeon-in-chief of the Massachusetts Memorial Hospital. He fulfilled his obligations to these Institutions with unusual and outstanding devotion, and upon his retirement in 1945 he was elected to their Board of Trustees.

Doctor Clute was interested in national and international affairs and through his contributions was made a member of many organizations, whose chief interest was in the advancement of surgery. In addition to the Southern Surgical Society, he was a member of the International Surgical Society, the American Surgical Association, the New England Surgical Society, and the American Society for the Study of Goitre. He was past president of the Boston Surgical Society and chairman of the credentials committee for the State of Massachusetts of the American College of Surgeons. He was a founder member of the American Board of Surgery and served on its examining committee for several years.

Clute was a skillful surgeon, a persistent student, an excellent diagnostician, and an able teacher. He had the rare ability to apply his native talents in a manner that successfully combined his analytical mind, dexterity, and common sense. His patients, his consultants, and his friends admired and adored him.

Howard Clute was known for his interest in humanity. He loved a party and engaged in the usual sports to some extent. His happiest moments outside the operating room were those spent with his cronies. Bridge, perhaps being his chief diversion, with his classmates Ben Ames Williams and Leland Powers, Jr., he spent many happy evenings. These companions of literary and legal fame doubtless tried to keep him from working too hard, but probably in an indirect manner spurred him on to attain a high peak of success in his own field.

His contributions to the surgical literature were numerous. Many of his observations and deductions will live in the minds of students of surgery for decades to come. The practical and useful side to his papers will long be remembered by his colleagues.

Clute died in the harness as he would have wished it. Having performed a successful and difficult operation in the morning, and run off a busy office hour in the afternoon, he went to his home and quietly passed from this world into the next. Those of us who knew him in his last years admired his spirit, his courage, and his determination to carry on in spite of his earlier attacks of coronary thrombosis.

Doctor Clute is survived by his devoted wife, a son Charles, and a daughter Alice. He was a good husband and father. Not only will these members of his family be glad to have known this man but so will his friends and associates remember his fine qualities, his keen wit, and his devotion to the art of surgery.

ARTHUR W. ALLEN, M.D.

WALTER E. DANDY

1886-1946

THE DEATH of Walter E. Dandy on Good Friday, 1946, came as a surprise to many people. A few premonitory symptoms of the fatal coronary occlusion had been misinterpreted during his winter vacation in Florida. There had been sufficient anginal pain during the last two weeks of his life to cause him to have electrocardiographic studies, but the final episode came with that stunning suddenness which one sees so often in coronary disease. Doctor Dandy was born in Sedalia, Mo., in April, 1886. He was the only child of parents who had



Walter E. Dandy

come from England a few years before he was born. His exceptional mental capacity was recognized early in life, and his fourth-grade teacher, Miss Cousley, encouraged him to do two years work in one year. He led his class on graduation from high school and took his collegiate work at the University of Missouri.

At college Walter Dandy was particularly interested in biology, and became an assistant to Doctor Curtis, the head of that department. It was due to the advice of this teacher that his exceptional pupil entered the Medical School at Johns Hopkins with advanced standing. Here he spent his spare hours doing investigative work in anatomy. Fortunately he was attracted to neurosurgery while a student, and never wavered from his determination to become foremost

in this field. It is not surprising, therefore, that Cushing's refusal to take him to Boston in 1912 was a disappointment that depressed Doctor Dandy for months. Late in life he remarked that Cushing's decision was the best thing that had ever happened to him.

After spending eight years as a house officer, assistant resident and resident in general surgery at the Johns Hopkins Hospital, Doctor Dandy put in one year on a full-time basis, and then went into private practice.

It was during his year as assistant resident (1913) that Dandy and Blackfan worked out the pathogenesis of hydrocephalus. This work caused Doctor Halsted to say to Doctor Park, "Dandy will never do anything equal to this again. Few men make more than one great contribution to medicine." But Doctor Halsted was mistaken for, in 1918, Doctor Dandy published his epochal paper on ventriculography. Before this technic was developed it had been possible to localize about one-third of all brain tumors. After the method was perfected it was possible to locate virtually every tumor.

Doctor Dandy's intellectual energy was incessant and sustained, as is shown by the continual flow of original contributions which he made to neurosurgery. One need only mention his method for removing acoustic nerve tumors, his successful operations for tic douloureux; glossopharyngeal tic; Meniere's disease; brain abscess; and his treatment of intracranial aneurysms. He was the first to operate for a displaced intervertebral disk, but did not immediately realize the frequency or significance of this lesion.

A careful study of the mind of Walter Dandy revealed three exceptional qualities, and it was the combination of these that accounts for his contributions. First, he had the habit of constantly asking himself searching questions. Second, he had the faculty of going right to the heart of a problem. Third, he had the faculty of seeing and thinking only in absolute terms. Every issue was either black or white; there were no intermediate shades. This all-or-none attitude was characteristic of his relationship to people.

Doctor Dandy was exceptionally daring when operating, but those who assisted him were not impressed by this quality as much as they were by his dexterity. As a technical surgeon he was unrivalled.

Finally, it is right that some comment be made on his ability as a teacher. He fascinated students because his teaching was crystal clear and very positive. His diagnoses on ward rounds were sometimes wrong, but they were never indecisive. His residents received a merciless drill. They were required to follow their postoperative patients hourly; to practice meticulous asepsis; to anticipate every move of their chief when operating. They were slaves, but responsible slaves. The training they received was priceless.

The following tribute had been prepared and was to have been given to Walter Dandy on his sixtieth birthday, but his illness prevented the celebration of the occasion:

"In every field of human endeavor there is occasionally one individual whose achievements set him apart from all his predecessors and above all his contemporaries. Often there is no appreciation of his accomplishments during

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his lifetime, and it is left for posterity to acclaim his work. Sometimes, however, the importance of the man's achievements are recognized and some expression of appreciation is given him. This testimonial is such an expression of appreciation, and is given to Dr. Walter E. Dandy in recognition of his accomplishments in the field of neurosurgery. It can be said in all truthfulness that his contributions to this subject are greater than those of any other person. It is fitting, therefore, that the occasion of Doctor Dandy's sixtieth birthday be celebrated by his friends, who give him this portfolio as an enduring emblem of their loyalty to him and of their recognition of his incomparable achievements at the Johns Hopkins Hospital."

WARFIELD M. FIROO, M.D.

JOHN STAIGE DAVIS

1872-1946

IN THE LATE AFTERNOON of December 23, 1946, while final preparations for family reunions and joyful Christmas festivities were being completed in millions of homes throughout our land, the good people of Baltimore were rudely shocked by the sudden death of one of their most distinguished and best-beloved surgeons, Dr. John Staige Davis.

My acquaintance with him, which began as a fellow-Virginian, dates back almost to the beginning of our respective careers more than 40 years ago



John Staige Davis

and, through mutual professional interests and activities centering mainly at the Johns Hopkins Hospital and the Union Memorial Hospital, soon ripened into an intimate, congenial and enduring friendship, the memories of which I shall always dearly cherish.

Doctor Davis was born in Norfolk, Virginia, January 15, 1872, the son of William B. and Mary Jane (Kentie) Howland Davis, and later became the third generation of doctors in the family. His ancestors on both sides from Colonial times were Virginians. At the time of his birth, his father was Assistant Surgeon in the U. S. Naval Hospital at Portsmouth, Virginia, but later transferred to the U. S. Army and, as Assistant Surgeon, established a long

record of loyal service to our country. Young Staige attended the Episcopal High School of Virginia, 1887-1888, then Saint Paul's School at Garden City, Long Island, which was then a military school, from 1888 until his graduation in 1892. From there he entered Yale University in the Sheffield Scientific School in order to take biologic training under Professor Russell H. Chittenden. He graduated from Yale in June, 1895, and entered the Johns Hopkins University School of Medicine in the fall of that year, where he obtained his medical degree in 1899. He then served as Resident House Officer at the Johns Hopkins Hospital for one year and as Resident Surgeon and Superintendent at the Union Protestant Infirmary (now the Union Memorial Hospital) under the supervision of Dr. J. M. T. Finney for three years. Upon completion of his apprenticeship, Doctor Davis was appointed Assistant in Surgery at the Johns Hopkins Hospital Dispensary, and for several years participated in the Surgical Service of the Robert Garrett Children's Hospital. He also was Instructor in Surgery at the College of Physicians and Surgeons until that institution was later merged with the University of Maryland.

In 1907, he married Kathleen Gordon Bowdoin, whose exceptional charm, conspicuous talents and unfaltering devotion enabled her to create and to maintain that delightfully congenial home atmosphere which contributed so magnificently to his career. She now survives him together with one daughter, Mrs. Charles E. Scarlett, Jr., of Baltimore, and two sons, Major W. Bowdoin Davis of the Army Medical Corps, a graduate of Princeton University in 1934, and of the Johns Hopkins University School of Medicine in 1938, who, after serving one year as Surgical Intern at the Union Memorial Hospital, Baltimore, transferred to the Presbyterian Hospital, a unit of the Columbia Medical Center in New York, for several years of intensive apprenticeship in the field of general surgery and as Resident in plastic surgery before being assigned to duty in this specialty at the Valley Forge General Hospital in Pennsylvania. He has now been released from the U. S. Army Medical Corps and, happily, will continue his father's specialty in Baltimore. A second son, Howland Staige Davis, established a brilliant record as Lieutenant Commander in the Naval Air Corps during the recent war. Five grandchildren also survive.

Doctor Davis served as Captain in the Medical Corps of the U. S. Army during World War I, from June, 1917, to January, 1919. During World War II he was appointed by the Surgeon General of the U. S. Army as a member of a committee to organize plastic surgery units for the Army Medical Corps. He also assisted with his advice and experience at the Walter Reed General Hospital, in Washington, and in other army hospitals during the war years. Furthermore, he was a member of the Advisory Committee for Medical Preparedness in Maryland, and of the Subcommittee on Plastic and Maxillofacial Surgery of the Division of Medical Sciences of the National Research Council.

Early in his professional career he became interested in the mastery and development of plastic surgery, and was the first surgeon to devote himself

exclusively to that field, to the enrichment of which he so brilliantly contributed for 40 years. In 1919, he published a book, "Plastic Surgery: Its Principles and Practice," which still is regarded as an authoritative work. In addition, he contributed numerous excellent articles on plastic surgery to various surgical journals. But perhaps his most enduring contribution to the development of his specialty was made through his superb training of a long list of Resident House Officers in the several hospitals with which he was associated. From these inexperienced assistants at the operating table he exacted the same meticulous care of detail that so faultlessly characterized his own work, and, in return, with uncommon clarity, he generously imparted to them from his vast storehouse of knowledge and experience, lessons in plastic surgery that they will never forget and from which many patients will later benefit.

From 1923 to within a brief period prior to his death, Doctor Davis served as Associate Professor of Surgery in the Johns Hopkins University in charge of Plastic Surgery. In addition to this work, he participated actively in the affairs of the Union Memorial Hospital, where for many years he was first a member and later, Chairman of the Executive Committee of the Staff. Throughout most of his active career he served also as Visiting Plastic Surgeon to the Johns Hopkins Hospital, the Union Memorial Hospital, the Children's Hospital School, and the Hospital for the Women of Maryland. He was a member of the American Medical Association; the American Surgical Association, serving as Vice-president in 1937; the Southern Surgical Association, serving as President in 1940; the American Association of Plastic Surgeons, serving as President in 1945; the Interurban Surgical Society; The Baltimore City Medical Society and the Medical and Chirurgical Faculty of Maryland. He was certified by the American Board of Surgery, the American Board of Plastic Surgery and the American College of Surgeons. He was a member of the Military Order of the World War and the Sons of the American Revolution. Just before his death he resigned as Chairman of the American Board of Plastic Surgery, and had just been appointed to the Board of Regents of the American College of Surgeons. He was also a member of the Maryland Club, the Elkridge Club and the Yale Club of New York.

But how imperfectly does this brief recital of some of his achievements in the field of plastic surgery and of the honors so worthily bestowed upon him in recognition of them, portray my friend Staige Davis as I knew him! Creditable, to be sure, is this imposing summary, but it is altogether inadequate. One does not find here the secret of his irresistible personal magnetism which so endeared him to a host of colleagues, friends and grateful recipients of his professional skill. This is to be found rather in the collective attributes of his personality. He was a quiet, gentle person, richly endowed with intellect, sound judgment and an indomitable will, all of which were consecrated to the service of humanity. His sturdy countenance radiated character, honesty, sincerity, kindness, magnanimity, tolerance, sympathy and immeasurable patience. And the motivating force that activated his many virtues was a consuming and sustained desire modestly but efficiently to serve his fellow man, to relieve

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suffering, to correct deformities and disfiguring scars and blemishes, to restore function and to abolish the inferiority complexes that so often shackle and torture those unfortunates who require this branch of surgery. All of this he achieved magnificently and, in addition, as teacher, investigator, counselor and consultant, his influence in the development of plastic surgery reached far beyond Baltimore and contributed in no small measure to the rehabilitation of thousands of veterans of two world wars.

He was a member of Saint Paul's Protestant Episcopal Church of Baltimore, and as fine a Christian gentleman as I have ever known.

Approximately one month prior to his death, he was confined to his house for several weeks by order of his physician because of exhaustion from overwork. His prompt improvement was so reassuring, however, that he was permitted to attend the last meeting of the Southern Surgical Association at Hot Springs, Virginia, which both he and Mrs. Davis thoroughly enjoyed. He returned to a slower operative schedule, and on the morning of December 23, 1946, he operated at the Union Memorial Hospital, had office hours, attended to some minor professional duties, and later lunched with a group of his colleagues at the Maryland Club. He was in excellent spirits and appeared to be rapidly regaining his strength. After lunch he rejoined his wife at home and lay down for a period of rest. He quietly and peacefully fell asleep, only to awaken shortly thereafter into a more abundant life which he so richly deserved. His passing is lamented by many, and his loss is indeed a grievous one, not only to his family and intimate friends, but also to Baltimore, the State of Maryland and American surgery.

EDWARD H. RICHARDSON, M.D.

SAMUEL LABAN LEDBETTER

1886-1946

SAMUEL LABAN LEDBETTER, son of Samuel L. and Nettie Morrow Ledbetter, was born in Birmingham, Alabama, February 26, 1886. He attended the Birmingham public schools, and received the Bachelor of Science degree from the University of Alabama in 1906. He entered the School of Medicine of Johns Hopkins University in the fall of 1906, and received the degree of Doctor of Medicine from that institution in 1910. On graduation, he was



Samuel L. Ledbetter

appointed to membership on the resident staff of the Lakeside Hospital, of Cleveland, where he served for five years, going progressively through the grades of house officer, assistant resident surgeon, and resident surgeon, on the service of the late Dr. George Crile. This association stimulated in him a life-long interest in goiter, and during his active career, he enjoyed a very large clientele of patients suffering from this disease.

When, in World War I the Lakeside Hospital Unit of Western Reserve University was organized, Doctor Ledbetter joined this group and served as resident surgeon, American Ambulance, Neuilly-sur-Seine, in 1915.

After his return from military service, he began the practice of surgery in Birmingham, and was most successful. In addition to holding membership in the County, State and American Medical Associations, he was a fellow of the Southern Surgical Association, of which he was Vice-president in 1937;

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of the American College of Surgeons, of which he was a member of the Board of Governors at the time of his death; of the American Association for the Study of Goiter; and was a member of the Founders-group of the American Board of Surgery. He was also a member of the Birmingham Surgical Society and the Birmingham Clinical Club. He was surgeon to St. Vincent's Hospital, the Children's Hospital, and the Hillman Hospital; and was consulting surgeon to the Woodward Iron Company, the Employees' Hospital of the Tennessee Coal, Iron and Railroad Company, Fairfield, and to the American Cast-iron Pipe Company.

When the Medical College of Alabama was moved from Tuscaloosa to Birmingham, in 1945, Doctor Ledbetter was made Clinical Professor of Surgery, but ill health prevented him from taking active part in the work of the College.

In spite of the demands of his large surgical practice, Doctor Ledbetter was much interested in sports and in the social activities of the city. He spent many leisure hours in hunting and fishing; was a member of the Mountain Brook Country Club; and was keenly interested in football.

In 1918, he married Frances Hoke Robinson, of Easley, South Carolina. She, and a daughter, Mrs. W. W. McPhillips, and two grandchildren survive him.

Doctor Ledbetter was an active member of the Episcopal Church.

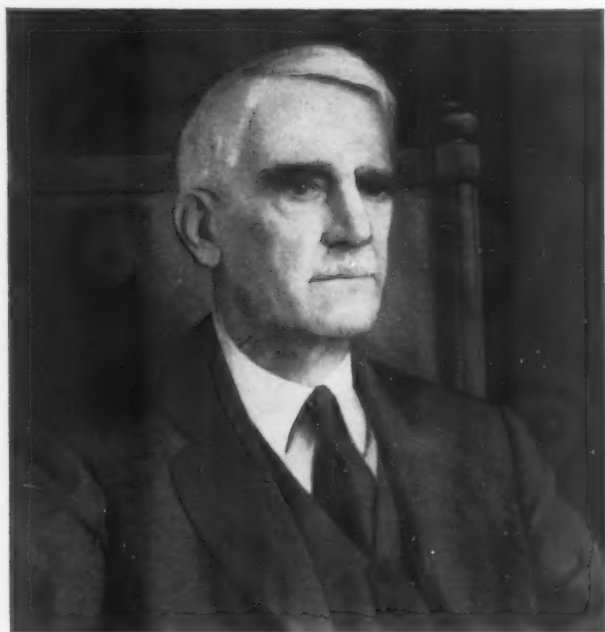
His illness was prolonged and, in the latter months, painful. For years he carried on bravely and actively, knowing full-well the fate that awaited him. Several operations were undertaken for relief of complications that arose from time-to-time. Finally, he had to give up the struggle, and died on March 10, 1946.

JAMES M. MASON, M.D.

JOHN CHADWICK OLIVER

May 7, 1862–March 14, 1946

THE OLIVERS came early to the western country, in fact Dr. David Oliver, grandfather of John C., was the first white child born among the pioneers of the Marietta Colony on the Muskegon in the year 1792. He was the son of New England frontiersmen who followed General Israel Putnam to the Ohio country before the turn of the nineteenth century. Dr. David Oliver grew up and came to Cincinnati where he practiced his profession in the West End many years ago. It is not stated whether he knew well, or had much connection



John Chadwick Oliver

with Dr. Daniel Drake but the two were in Cincinnati at about the same time.

Doctor Drake, known as the father of western medicine, founded the Ohio Medical College in Cincinnati in 1819, and, later on, just to show that he could, he founded the Miami Medical College as a branch of the Miami University at Oxford, Ohio in 1852. It was at this latter college that Dr. John Oliver attended and, at the age of 23, namely, 1885, he graduated with honors.

Dr. Cornelius George Comegys, a contemporary of Daniel Drake, took Doctor Oliver into his office as his assistant. Doctor Oliver immediately began to serve his Alma Mater as demonstrator in anatomy and later as professor of

anatomy. Under Doctor Comegys' tutorage Doctor Oliver progressed rapidly in his chosen profession and upon his friend's demise, in 1896, he became associated in the practice of surgery with the greatly loved and esteemed Dr. N. P. Dandridge, then Dean of the Miami Medical College.

Later, Doctor Oliver himself became Dean of that honored institution and, as such, initiated the movement to unite the Miami Medical College with the Ohio Medical College. After a long bitter struggle this was done to form first, the Ohio-Miami Medical College of the University of Cincinnati and later the name was shortened to the College of Medicine of the University of Cincinnati.

After the death of Dr. Christian R. Holmes in 1920 Doctor Oliver became Dean of the College of Medicine of the University of Cincinnati. After serving in that capacity for several years he resigned.

Doctor Oliver was a cultured gentleman of strict integrity and a great surgeon. As a teacher and a colleague he set an example of faithful observance in medical ethics. As a writer he was clear and concise. In the writings in the local journals and the annals of the American Surgical Association and the Southern Surgical Association many contributions may be found.

In October, 1888, he married Carrie Frances Wright who bore him three children. Dr. Wade Wright Oliver, the eldest, is now the Professor of Bacteriology at the Long Island Medical College. Dr. Symmes Francis Oliver, a surgeon in Cincinnati, is at present connected with the Veterans' Bureau, and a daughter, Sarah Elizabeth Kerper, lives in Washington, D. C.

In 1902 Doctor Oliver was elected to the Southern Surgical Association and came regularly for a good number of years. However, age and ill health have kept him away for the last few years, but those of us in and about Cincinnati knew him well and will sadly miss him.

RALPH G. CAROTHERS, M.D.

NEW EDITORIAL ADDRESS

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BOOK REVIEW

MEN WITHOUT GUNS. Text by DeWitt Mackenzie. Descriptive captions by Major Clarence Worden. Foreword by Major General Norman T. Kirk. Illustrated with 137 colored plates. Blakiston Co., Philadelphia, 1945.

"**MEN WITHOUT GUNS**" is a combination of narrative and illustrations giving that part of the history of World War II that deals with the care of the wounded from the forward areas and battle fronts of the various theaters back to the large hospital centers within the United States. The various theaters, beginning with the Southwest Pacific, are treated separately, both as to text and sketches. A foreword by the Surgeon-General, Norman T. Kirk, M. C., U. S. A., emphasizes the heroism and skill of the men and women of the Army Medical Corps. He properly lists three of the war's outstanding innovations in establishing an excellent record for the care of the wounded—surgery, the sulfa drugs, and penicillin. Qualifying this, he says: "Surgery is Number One; it isn't the sulfa drugs that save lives, it's surgery; drugs supplement surgery." The brief summary of General Kirk's accomplishments in meeting the tremendous task of caring for the wounded is well done.

In considering the function of the Army Medical Corps, one might judge from this book that the difficulties were for the most part the result of combat conditions, the weather and terrain in particular. Many of the medical officers of the Army may well question this from their experience because the successful accomplishment of the day's work in the Medical Corps was often in spite of existing cumbersome Army regulations so religiously adhered to by old regular Army officers. However, now that the war has been successfully completed it may be just as well to indulge in a little euphoria from the standpoint of making the review of it as pleasant as possible. Nevertheless, in fairness to those of the medical profession who may participate in the next war, greater emphasis should be placed upon the long periods of waiting and the possibility of improper assignments rather than the physical hardships of the tropical mud and mould or the Normandie cold and blitz bombs.

The medical corpsman is the hero of this book and rightfully so because of all the tasks that any member of the Medical Department of the Army is called upon to do no other requires as much bravery, singleness of purpose, and clearness of mind under fire. These men, common to every medical unit near a front, are pictured in action.

The twelve artists who have contributed to this volume have by great attention to detail plus the knowledge that comes from being on the spot during action given an accurate picture of various aspects of caring for the wounded of this war. They are earthy, they carry the background of the situation, they present much in one sketch; sometimes it may have been added onto from their memory but, regardless, it reveals what was then taking place. In these illustrations there is a virile integrity that pervades the entire book which is admirable. There has been no magnification of the horrors nor has there been covering up of the unpleasant. A short biography of each artist, including his assignment and contributions, adds to the reader's personal interest in each group of paintings and sketches. That these artists escaped without major mishap in their assignments is remarkable. Over two-thirds of the book consists of paintings and sketches without duplication.

This book will appeal in particular to the doctors, nurses, and corpsmen of the Army of World War II. Those who were overseas will find their greatest interest in those paintings and sketches from the theater in which they served, be it Southwest Pacific, Burma-India, or European. It is not likely to have more than passing attention from those who were not in some way directly concerned with the care of the wounded.

FRANK GLENN, M.D.